# SCIENCE

FRIDAY, NOVEMBER 7, 1913

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## *INDUSTRIAL RESEARCH IN AMERICA*[1]

GERMANY has long been recognized as preeminently the country of organized research. The spirit of research is there imminent throughout the entire social structure. This is not the time nor place, however, nor is it necessary before this audience, to refer in any detail to the long record of splendid achievement made by German research during the last fifty years. It is inscribed in luminous letters around the rock upon which Germany now stands secure among the nations of the world.

The virility and range of German research were never greater than they are to-day. Never before have the superb energy and calculated audacity of German technical directors and German financiers transformed so quickly and so surely the triumphs of the laboratory into industrial conquests. Never has the future held richer promise of orderly and sustained progress, and yet the preeminence of Germany in industrial research is by no means indefinitely assured. A new competitor is even now girding up his loins and training for the race, and that competitor is strangely enough the United States—that prodigal among nations, still justly stigmatized as the most wasteful, careless and improvident of them all.

To one at all familiar with the disdain of scientific teaching which has characterized our industry, and which still persists in many quarters, this statement is so contrary to the current estimate that its general acceptance can not be expected. It will

[1] Presidential address at the forty-eighth meeting of the American Chemical Society, Rochester, N. Y.

have served its purpose if it leads to a consideration of the facts which prove the thesis.

The country of Franklin, Morse and Rumford; of McCormick, Howe and Whitney; of Edison, Thomson, Westinghouse and Bell; and of Wilbur and Orville Wright, is obviously a country not wholly hostile to industrial research or unable to apply it to good purpose. It is, however, not surprising that with vast areas of virgin soil of which a share might be had for the asking; with interminable stretches of stately forest; with coal and oil and gas, the ores of metals and countless other gifts of nature scattered broadcast by her lavish hand, our people entered upon this rich inheritance with the spirit of the spendthrift, and gave little heed to refinements in methods of production and less to minimizing waste. That day and generation is gone. To-day, their children, partly through better recognition of potential values, but mainly by the pressure of a greatly increased population and the stress of competition among themselves and in the markets of the world, are rapidly acquiring the knowledge that efficiency of production is a sounder basis for prosperity than mere volume of product, however great. Many of them have already learned that the most profitable output of their plant is that resulting from the catalysis of raw materials by brains. A far larger number are still ignorant of these fundamental truths, and so it happens that most of our industrial effort still proceeds under the guidance of empiricism with a happy disregard of basic principles. A native ingenuity often brings it to a surprising success and seems to support the aphorism "Where ignorance is profitable, 'tis folly to be wise." Whatever may be said, therefore, of industrial research in America at this time is said of a babe still in the cradle but which has nevertheless, like the infant Hercules, already destroyed its serpents and given promise of its performance at man's estate.

The long-continued and highly organized research which resulted in the development of American agricultural machinery has led to the general introduction of machines which reduce the labor cost of seven crops $681,000,000 as measured by the methods of only fifty years ago.

The superhuman dexterity and precision of American shoe machinery, which has revolutionized a basic industry and reduced competition to the status of an academic question, present American industrial research at its best. They are not the result of the individual inspiration of a few inventors as is commonly supposed. They represent years of coordinated effort by many minds directed and sustained by constant and refined experimental research.

You need not be reminded that the ubiquitous telephone is wholly a product of American research. Munchausen's story of the frozen conversation which afterward thawed out is a clumsy fable. Think of the Niagaras of speech pouring silently through the New York telephone exchanges where they are sorted out, given a new direction and delivered audibly perhaps a thousand miles away. New York has 450,000 instruments—twice the number of those in London. Los Angeles has a telephone to every four inhabitants. Why should one care to project one's astral body when he can call up from the club in fifteen seconds? Our whole social structure has been reorganized, we have been brought together in a single parlor for conversation and to conduct affairs because the American Telephone and Telegraph Company spends annually for research, the results of which are all about us, a sum greater than the total income of many universities.

The name of Edison is a household word

in every language. The Edison method is a synonym for specialized, intense research which knows no rest until everything has been tried. Because of that method and the unique genius which directs its application, Italian operas are heard amid Alaskan snows and in the depths of African forests; every phase of life and movement of interest throughout the world is caught, registered, transported and reproduced that we may have lion hunts in our drawing-rooms and the coronation in a five-cent theater. From his laboratory have come the incandescent lamp, multiple telegraphy, new methods of treating ores and a thousand other diverse inventions, the development of a single one of which has sometimes involved millions.

The development of the automobile, and especially of the low-priced American car, is a thing of yesterday. To-day a single manufacturer turns out two cars a minute, while another is expanding his output to 500 cars a day. Every 23 days the total engine horse-power of new cars of one small type equals the energy of the entire Mississippi river development at Keokuk. Every 46 days this engine output rises to the total energy development at Niagara Falls. The amount of gasoline consumed upon our roads is equal to the water supply of a town of 40,000 inhabitants, and its cost on Sundays and holidays is $1,000,000.

It goes without saying that any such development as that of the automobile industry in America has been based upon and vitalized by an immeasurable amount of research, the range and influence of which extends through many other industries. It has accelerated the application of heat treatment more than any other agency. One tire manufacturer spends $100,000 a year upon his laboratory. The research department organized by my associates for one automobile company comprised within its staff experts in automobile design, mathematics, metallography and heat treatments, lubrication, gaseous fuels, steel and alloys, paints and painting practise, in addition to the chemists, physicists and assistants for routine or special work.

The beautiful city whose hospitality has so greatly added to the pleasure and success of the present meeting of our society is the home of two highly scientific industries of which any community may well be proud. The Bausch & Lomb Optical Company, through its close affiliation with the world-famed Zeiss works at Jena, renders immediately available in this country the latest results of German optical research. The Eastman Kodak Company is perhaps more generally and widely known than even the Zeiss works, and in capital, organization, value of product and profit of operation will bear comparison with the great German companies whose business is applied science. Like them, it spends money with a lavish hand for the promotion of technical research and for the fundamental investigation of the scientific bases on which its industry rests. As you have happily been made aware, this work is carried on in the superb new research laboratories of the company with an equipment which is probably unrivalled anywhere for its special purposes. The laboratory exemplifies a notable feature in American industrial research laboratories in that it makes provision for developing new processes first on the laboratory scale and then on the miniature factory scale.

To no chapter in the history of industrial research can Americans turn with greater pride than to the one which contains the epic of the electrochemical development at Niagara Falls. It starts with the wonderful story of aluminum. Discovered in Germany in 1828 by Wöhler, it cost in 1855, $90 a pound. In 1886, it had fallen to $12.

The American Castner process brought the price in 1889 to $4. Even at this figure it was obviously still a metal of luxury with few industrial applications. Hall in America and Héroult simultaneously in Europe discovered that cryolite, a double fluoride of sodium and aluminum, fused readily at a moderate temperature, and when so fused dissolved alumina as boiling water dissolves sugar or salt, and to the extent of more than 25 per cent. By electrolyzing the fused solution aluminum is obtained. On August 26, 1895, the Niagara works of the Pittsburgh Reduction Co., started at Niagara Falls the manufacture of aluminum under the Hall patents. In 1911, the market price of the metal was 22 cents and the total annual production 40,000,000 pounds.

A chance remark of Dr. George F. Kunz, in 1880, on the industrial value of abrasives, turned the thoughts of Acheson to the problem of their artificial production and led to the discovery, in 1891, of carborundum and its subsequent manufacture on a small scale at Monongahela City, Pennsylvania. In 1894, Acheson laid before his directors a scheme for moving to Niagara Falls, when to quote his own words:

> To build a plant for one thousand horse-power, in view of the fact that we were selling only one half of the output from a one hundred and thirty-four horse-power plant, was a trifle too much for my conservative directors, and they, one and all, resigned. Fortunately, I was in control of the destiny of the Carborundum Company. I organized a new board, proceeded with my plans, and in the year 1904, the thirteenth from the date of the discovery, had a plant equipped with a five-thousand electrical horse-power and produced over 7,000,000 pounds of those specks I had picked off the end of the electric light carbon in the spring of 1891.

The commercial development of carborundum had not proceeded far before Acheson brought out his process for the electric furnace production of artificial graphite and another great Niagara industry was founded. In quick succession came the Willson process for calcium carbide and the industrial applications of acetylene; phosphorus; ferro-alloys made in the electric furnace; metallic sodium, chlorine and caustic soda first by the Castner process, later by the extraordinarily efficient Townsend cell; electrolytic chlorates and alundum.

Perhaps even more significant than any of these great industrial successes was the Lovejoy & Bradley plant for the fixation of atmospheric nitrogen which was perforce abandoned. It is well to recall, in view of that reputed failure, that the present-day processes for fixing nitrogen have made little if any improvement in yields of fixed nitrogen per kilowatt hour over those obtained in this pioneer Niagara plant.

In the year 1800, a young assistant of Lavoisier, E. I. du Pont by name, emigrated to this country with others of his family and settled on the banks of the Brandywine, near Wilmington, Del. He engaged in the manufacture of gunpowder. To-day the du Pont Company employs about 250 trained chemists. Its chemical department comprises three divisions: the field division for the study of problems which must be investigated outside the laboratory and which maintains upon its staff experts for each manufacturing activity, together with a force of chemists at each plant for routine laboratory work; second, the experimental station which comprises a group of laboratories for research work on the problems arising in connection with the manufacture of black and smokeless powder, and the investigation of problems or new processes originating outside the company; third, the eastern laboratory which confines itself to research concerned with high explosives; its equipment is housed in 76 buildings, the majority being of considerable size, spread over 50 acres.

Since no industrial research laboratory can be called successful which does not in due time pay its way, it is pleasant to record that the eastern laboratory is estimated to yield a profit to its company of $1,000,000 a year. In addition to the generous salaries paid for the high-class service demanded by the company, conspicuous success in research is awarded by bonus payments of stock.

In Acheson and Hall have been already named two recipients of the Perkin medal, the badge of knighthood in American industrial research. The distinguished and thoroughly representative juries which award the medal annually had previously bestowed it upon Herreshoff for his work in electrolytic copper refining, the contact process for sulphuric acid and the invention of his well-known roasting furnace, and upon Behr for creative industrial research in the great glucose industry. In 1912, it was received by Frasch, and this year it was awarded Gayley.

The Gayley invention of the dry air blast in the manufacture of iron involves a saving to the American people of from $15,000,000 to $29,000,000 annually. A modern furnace consumes about 40,000 cubic feet of air per minute. Each grain of moisture per cubic foot represents one gallon of water per hour for each 1,000 cubic feet entering per minute. In the Pittsburgh district the moisture varies from 1.83 grains in February to 5.94 grains in June, and the water per hour entering a furnace varies accordingly from 73 to 237 gallons. In a month a furnace using natural air received 164,500 gallons of water, whereas with the dry blast it received only 25,524 gallons. A conservative statement according to Professor Chandler is that the invention results in a 10 per cent. increase in output and a 10 per cent. saving in fuel.

Especially notable and picturesque among the triumphs of American industrial research is that by means of which Frasch gave to this country potential control of the sulphur industry of the world. There is in Calcasieu Parish, La., a great deposit of sulphur 1,000 feet below the surface under a layer of quicksand 500 feet in thickness. An Austrian company, a French company and numerous American companies had tried in many ingenious ways to work this deposit, but had invariably failed. Misfortune and disaster to all connected with it had been the record of the deposit to the time when Frasch approached its problem in 1890. He conceived the idea of melting the sulphur in place by superheated water forced down a boring, and pumping the sulphur up through an inner tube. In his first trial he made use of twenty 150 h.-p. boilers grouped around the well, and the titanic experiment was successful. The pumps are now discarded and the sulphur brought to the surface by compressed air. A single well produces about 450 tons a day, and their combined capacity exceeds the sulphur consumption of the world.

An equally notable solution of a technical problem which had long baffled other investigators is the Frasch process for refining the crude, sulphur-bearing, Canadian and Ohio oils. The essence of the invention consists in distilling the different products of the fractional distillation of the crude oil with metallic oxides, especially oxide of copper, by which the sulphur is completely removed while the oils distill over as odorless and sweet as if from the best Pennsylvania oil. The copper sulphide is roasted to regenerate the copper. The invention had immense pecuniary value. It sent the production of the Ohio fields to 90,000 barrels a day and the price of crude Ohio oil from 14 cents a barrel to $1.00.

Turning from these examples of individual achievement so strongly character-

istic of the genius of our people in one aspect, let us again consider for a moment that other and even more significant phase of our industrial research, namely, that which involves the coordinated and long-continued effort of many chemists along related lines.

Chemistry in America is essentially republican and pragmatic. Most of us believe that the doctrine science for science's sake is as meaningless and mischievous as that of art for art's sake, or literature for literature's sake. These things were made for man, not for themselves, nor was man made for them. Most of us are beginning to realize that the major problems of applied chemistry are incomparably harder of solution than the problems of pure chemistry, and the attack, moreover, must often be carried to conclusion at close quarters under the stress and strain induced by time and money factors. Under these circumstances it should not excite surprise that a constantly rising proportion of our best research is carried on in the laboratories of our great industrial corporations, and nowhere more effectively than in the research laboratory of the General Electric Company under the guidance of your past president, Dr. Whitney. As to the laboratory method Dr. Whitney says in a personal letter:

> We see a field where it seems as though experimental work ought to put us ahead. We believe that we need to get into the water to learn to swim, so we go in. We start back at the academic end as far as possible, and count on knowing what to do with what we find when we find it. Suppose that we surmise that, in general, combustible insulation material could be improved upon. We try to get some work started on an artificial mica. May be we try to synthesize it and soon come to a purely theoretical question; *e. g.*, is it possible to crystallize such stuff under pressure in equilibrium with water vapor corresponding to the composition of real mica? This may lead a long way and call in a lot of pure chemistry and physical chemistry. Usually we just keep at it, so that if you haven't seen it on the market we're probably at it yet.

In striking contrast to the secrecy maintained between individual workers in large German research laboratories, is the almost universal custom in America to encourage staff discussion. In the General Electric Laboratory, as in many others, the weekly seminars and constant helpful interchange of information has developed a staff unity and spirit which greatly increases the efficiency of the organization and raises that of the individual to a higher power.

Many evenings could profitably be spent in discussing the achievements of this laboratory. Their quality is well indicated by the new nitrogen tungsten lamp, with its one half watt per candle, which combines the great work of Dr. Coolidge on ductile tungsten with the studies of Langmuir and others of the staff on the particular glass and gas and metal which are brought together in this lamp.

Any attempt to adequately present the enormous volume of research work, much of which is of the highest grade, constantly in progress in the many scientific bureaus and special laboratories of the general government or even to indicate its actual extent and range, is of course utterly beyond the limits of my attainments or of your patience. The generous policy of the government toward research is unique in this, that the results are immediately made available to the whole people. Heavy as some of the government reports are, they can not be expected to weigh more than the men who write them. Some, like the "Geochemistry" of F. W. Clarke, are of monumental character. A vast number are monographs embodying real and important contributions to scientific knowledge or industrial practise. Some, as would be expected, are little more than compilations or

present the results of trivial or ill-considered research.

The United States is still essentially an agricultural country and agriculture is, in its ultimate terms, applied photo-chemistry. The value of our farm property is already over $42,000,000,000, and each sunrise sees an added increment of millions. Even small advances in agricultural practise bring enormous monetary returns. The greatest problem before the country is that of developing rural life. While our people still crowd into already congested cities, some are beginning to realize that Long Acre Square is not a wholly satisfying substitute for Long Acre Farm, and to question whether the winding, fern-fringed country roads of Vermont may not be a better national asset than the Great White Way.

Chief, therefore, among the government departments, in the volume of industrial research is of course the Department of Agriculture, which includes within its organization ten great scientific bureaus, each inspired by an intense pragmatism and aggressively prosecuting research in its allotted field. The magnitude of these operations of the department may be inferred from the fact that it spent for printing alone during the fiscal year just ended $490,000. The activities of its army of agents literally cover the earth, and its annual expenditure runs to many millions. The Bureau of Soils, the Bureau of Plant Industry, the Bureau of Animal Industry and the Forest Service have to do with the very foundations of our national existence and prosperity, and their researches have added billions to the national wealth. The Bureau of Chemistry, through its relation to the enforcement of the pure food law and the inspection of meats before interstate shipment, is as ubiquitous in its influence as the morning newspaper and touches the daily life of the people almost as closely. The consumer is by no means the only one benefited by its activities. Manufacturers are protected from the unfair competition of less scrupulous producers. The progress of research is stimulated not only by investigations within the bureau, but by their reaction upon the manufacturers of food products who are rapidly being brought to establish laboratories of their own. The food work of the bureau is supplemented and extended by the laboratories of the state and city boards of health, of which that of Massachusetts has been notable for productive research. Special laboratories within the bureau carry its influence and investigations into other fields as in case of the paper and leather laboratory.

The office of Public Roads of the department, mindful of the fact that less than ten per cent. of the total road mileage of the country has ever been improved, maintains a large organization of engineers, chemists and other scientists to conduct investigations and compile data, the ultimate purpose of which is to secure efficiency and economy in the location, construction and maintenance of country roads, highways and bridges.

The research work of the Department of Agriculture is greatly augmented and given local application through the agency of 64 state agricultural experiment stations established for the scientific investigation of problems relating to agriculture. These stations are supported, in part, by federal grants, as from the Hatch and Adams funds, and for the rest by state appropriations. Their present income exceeds $3,000,000. All are well equipped; one of them, California, includes within its plant a superb estate of 5,400 acres with buildings worth $1,000,000.

The station work is organized upon a national basis but deals primarily with the problems of the individual states. The effi-

ciency of their work is stimulated by the requirement of the Adams Fund that appropriation shall be confined to definite projects. The number of such projects during 1910 was 335 and during 1911, 290. The reduction in number in no way implies diminished activity, and is due to more careful selection and preparation, with elimination of trivial and merely demonstrational projects. While the work of the stations necessarily covers a wide range of subjects, many of which would not be regarded as chemical in nature, a notable proportion has to do directly with chemical projects. Only the briefest reference can be made to a few of these:

At Connecticut, Osborne's studies of proteins and their feeding values have developed differences as great in their assimilability as those existing between the different carbohydrates.

Kansas has a department for the study of problems in handling and milling grain with an experimental baking plant for testing the bread-making capacity of flours. The millers are actively cooperating.

Minnesota has a similar thoroughly modern baking and testing laboratory for studies in wheat and flour chemistry and technology.

Arizona finds that date ripening may be so hastened by spraying the immature fruit with acetic acid that choice varieties are caused to ripen in that region.

The Cornell Station has demonstrated that the growth of a legume with a non-legume gives the latter a greater protein content than when grown alone.

Wisconsin has established the significance of sulphur as a plant food; grain crops, for example, remove nearly as much sulphur as they do phosphoric acid, whereas the soil supply of sulphur is far less.

Vermont is studying the forcing of plants by means of carbonic acid gas.

Idaho has raised the protein content of wheat by 50 per cent. Kentucky has developed a method for the detection of *Bacillus typhosus* in water, and North Dakota is conducting very extensive field tests on the durability of paints and oils.

These are, of course, mere surface references which hardly touch the real work of the stations. An enormous amount of research and routine work on fertilizers is constantly carried on by methods standardized by the Association of Official Agricultural Chemists. The theory of the action of fertilizers engages the effort of many research workers who find the problem far more complex than the old plant food theory assumed.

It may be said without fear of contradiction that through the combined efforts of the Department of Agriculture, the experiment stations, the agricultural colleges and our manufacturers of agricultural machinery there is devoted to American agriculture a far greater amount of scientific research and effort than is at the service of any other business in the world.

No other organic substance occurs in such abundance as wood, and few, if any, are more generally useful. About 150,000,000 tons of wood are still wasted annually in the United States. The Forest Products Laboratory which is maintained by the Forest Service in cooperation with the University of Wisconsin has for its purpose the development and promulgation of methods for securing a better utilization of the forest and its products, and its research work is directed to that end. The laboratory is splendidly equipped with apparatus of semi-commercial size for work in timber physics, timber tests, wood preservation, wood pulp and paper and wood distillation and chemistry.

In the United States Patent Office, Dr. Hall has developed a remarkably compre-

hensive index to chemical literature which now contains 1,250,000 cards and which is open to every worker. The Bureau of Fisheries devotes $40,000 to a single study and the Geological Survey, $100,000 to the investigation of the mineral resources of Alaska. It spent, in 1913, $175,000 for engraving and printing alone. The superb Geophysical Laboratory of the Carnegie Institution of Washington is also constantly engaged in the most refined researches into the composition, properties and mode of genesis of the earth's crust. The Smithsonian Institution is honored throughout the world for the efficiency of its effort to increase and diffuse useful knowledge among men.

The Bureau of Mines of the Department of the Interior was established to conduct in behalf of the public welfare fundamental inquiries and investigations into the mining, metallurgical and mineral industries. Its appropriation for the current fiscal year is $662,000, of which $347,000 is to be devoted to technical research pertinent to the mining industry. The bureau has revolutionized the use of explosives in mines. Over $8,000,000 worth of coal is now bought on the specification and advice of the bureau while more than 50 of the larger cities, a number of states and many corporations have adopted the bureau plan of purchase. Our own Dr. Parsons, as chief mineral chemist of the bureau, is carrying its researches into new and interesting fields.

Perhaps no better evidence could be adduced of the present range and volume of industrial research in America than the necessity, imposed upon the author of such a general survey as I am attempting, of condensing within a paragraph his reference to the Bureau of Standards of the Department of Commerce. Its purpose is the investigation and testing of standards and measuring instruments and the determination of physical constants and the properties of materials. To these objects it devotes about $700,000 a year to such good effect that in equipment and in the high quality and output of its work it has in ten years taken rank with the foremost scientific institutions in the world for the promotion of industrial research and the development and standardization of the instruments, materials and methods therein employed. Its influence upon American research and industry is already profound and rapidly extending. The bureau cooperates with foreign governments and institutions, and is constantly consulted by state and municipal officials, technical bodies, commissions and industrial laboratories as a court of highest appeal.

I can not better conclude this cursory and fragmentary reference to governmental work in applied science than with the words of the distinguished Director of the Bureau of Standards:

> If there is one thing above all others for which the activities of our government during the past two or three decades will be marked it is its original work along scientific lines, and I venture to state that this work is just in its infancy.

In view of the evidence offered by Germany of the far-reaching benefits resulting from the close cooperation which there obtains between the university laboratory and the industrial plant, it must be admitted with regret that our own institutions of learning have, speaking generally, failed to seize or realize the great opportunity confronting them. They have, almost universally, neglected to provide adequate equipment for industrial research, and, what is more to be deplored since the first would otherwise quickly follow, have rarely acquired that close touch with industry essential for familiarity and appreciation of its immediate and pressing needs.

There are happily some notable exceptions. Perhaps foremost among them stands the Massachusetts Institute of Technology with its superb engineering and testing equipment, its Research Laboratory of Applied Chemistry and the meritorious thesis work of its students in all departments. The biological department has been especially active and successful in extending its influence into industrial and sanitary fields, while unusual significance attaches to the motor vehicle studies just concluded and the more recently inaugurated special investigations in electricity, since both were initiated and supported by external interests. About two years ago the institute brought vividly before the community the variety and extent of its wide-spread service to industry by holding a Congress of Technology, at which all of the many papers presented recorded the achievements of institute alumni.

The Colorado School of Mines, recognizing that $100,000,000 a year is lost through inefficient methods of ore treatment, has recently equipped an experimental ore dressing and metallurgical plant in which problems of treatment applicable to ores of wide occurrence will be investigated. The Ohio State University has established an enviable reputation for its researches in fuel engineering. Cornell has been especially alive to the scientific needs of industrial practise, and a long experience with technical assistants enables me to say that I have found none better equipped to cope with the miscellaneous problems of indusrial research than the graduates of Cornell. It may in fact be stated generally that the quality of advanced chemical training now afforded in this country is on a par with the best obtainable in Germany, and that home-trained American youth adapt themselves far more efficiently to the requirements and conditions of our industries than do all but the most exceptional German doctors of philosophy who find employment here.

Several of the great universities of the middle west, notably those of Wisconsin and Illinois, have placed themselves closely in touch with the industrial and other needs of their communities and are exerting a fundamental and growing influence upon affairs. In the east, Columbia has recently established a particularly well equipped laboratory for industrial chemistry and is broadening its work in this department.

The universities of Kansas and of Pittsburgh are carrying forward an especially interesting experiment in the operation of industrial research fellowships supported by the special interests directly concerned. These fellowships endow workers for the attack of such diverse subjects as the chemistry of laundering, the chemistry of bread and baking, that of lime, cement and vegetable ivory, the extractive principles from the ductless glands of whales, the abatement of the smoke nuisance, the technology of glass, and many others. The results obtained are intended primarily for the benefit of the supporters of the individual fellowships but may be published after three years. The holder of the fellowship receives a proportion of the financial benefits resulting from the research, and the scale of sums allotted has progressively risen from $500 a year to $2,500 and even to $5,000. While some doubt may reasonably be expressed as to the possibility of close individual supervision of so many widely varying projects, the results obtained thus far seem entirely satisfactory to those behind the movement, which has further served to strongly emphasize the willingness of our manufacturers to subsidize research.

The present vitality and rate of progress in American industrial research is strik-

ingly illustrated by its very recent development in special industries. It has been said that our best research is carried on in those laboratories which have one client, and that one themselves.

Twenty-five years ago the number of industrial concerns employing even a single chemist was very small, and even he was usually engaged almost wholly upon routine work. Many concerns engaged in business of a distinctly chemical nature had no chemist at all, and such a thing as industrial research in any proper sense hardly came within the field of vision of our manufacturers. Many of them have not yet emerged from the penumbra of that eclipse and our industrial foremen, as a class, are still within the deeper shadow. Meantime, however, research has firmly established itself among the foundation stones of our industrial system, and the question is no longer "What will become of the chemists?" It is now, "What will become of the manufacturers without them?"

In the United States to-day, the microscope is in daily use in the examination of metals and alloys in more than 200 laboratories of large industrial concerns.

An indeterminate but very great amount of segregated research is constantly carried forward in small laboratories which are either an element in some industrial organization or under individual control. An excellent example of the quality of work to be credited to the former is found in the development of cellulose acetate by Mork in the laboratory of the Chemical Products Company, while a classic instance of what may be accomplished by an aggressive individualism plus genius in research is familiar to most of you through the myriad and protean applications of bakelite. The rapidity of the reduction to practise of Baekeland's research results is the more amazing when one considers that the distances to be traveled between the laboratory and the plant are often, in case of new processes and products, of almost astronomical dimensions.

Reference has already been made to the highly organized, munificently equipped and splendidly manned laboratories of the du Pont Company, the General Electric Company and the Eastman Kodak Company. There are in the country at least fifty other notable laboratories engaged in industrial research in special industries. The expenditure of several of them is over $300,000 each a year; the United States Steel Corporation has not hesitated to spend that amount upon a single research; the expenses of a dozen or more probably exceed $100,000 annually. The limits of any address delivered outside a jail unfortunately preclude more than the merest reference to a very few. One of the finest iron research laboratories in the world is that of the American Rolling Mills Co. Equally deserving mention from one aspect or another are the laboratories of the Fire Underwriters, the National Carbon Co., the Solvay Process Co., the General Bakelite Co., Parke, Davis & Co., the Berlin Mills Co., the United Gas Improvement Co., the National Electric Lamp Association, Swift & Co., the Pennsylvania Railroad and many others.

Research in the textile industries has been greatly stimulated by the various textile schools throughout the country, of which the Lowell Textile School with its superb equipment is perhaps best known. The fermentation industries have been brought upon a scientific basis largely through the efforts of the Wahl-Henius Institute at Chicago and other special schools. In the paper industry, general research is mainly confined to the Forest Products Laboratory at Madison, its branch laboratory for wood pulp at Wausau, the Bureau

of Standards, the Paper and Leather Laboratory of the Agricultural Department, and the laboratory of Arthur D. Little, Inc., at Boston. Our own special equipment for this purpose includes, as does that of some of the other laboratories named, a complete model paper mill of semi-commercial size.

There is no school of paper-making in the country, and one of our most urgent industrial needs is the establishment of special schools in this and other industries for the adequate training of foremen who shall possess a sufficient knowledge of fundamental scientific principles and method to appreciate the helpfulness of technical research. The Pratt Institute at Brooklyn is fully alive to this demand and has shaped its courses admirably to meet it.

The steel industry in its many ramifications promotes an immense amount of research ranging from the most refined studies in metallography to experimentation upon the gigantic scale required for the development of the Gayley dry blast; the Whiting process for slag-cement; or the South Chicago electric furnace. This furnace has probably operated upon a greater variety of products than any other electric furnace in the world. Regarding the steel for rails produced therein, it is gratifying to note that after two and a half years or more no reports of breakage have been received from the 5,600 tons of standard rails made from its output. The significance of this statement will be better appreciated when we consider that in 1885 the average total weight on drivers was 69,000 pounds. It had risen to over 180,000 pounds in 1907, and reached a maximum of 316,000 pounds in that year. The weight of rails during the same period had increased from 65–75 pounds to 85–100 pounds. In 1905, conditions were so bad that out of a lot of 10,000 tons, 22 per cent. were removed the first year because of depressions in the head. In 1900, the American Railway Engineering Association took the matter in hand and studied the influence and extent of segregation of specific impurities. The work was at first confined to phosphorus but has been extended to other constituents. Fay called attention to the highly deleterious influence of sulphide of manganese.

The great railway systems have been quick to cooperate in these researches which with others of fundamental importance have been extended by the American Society for Testing Materials, the Master Car Builders' Association, and other organizations. Materials of construction have constituted a fertile subject of inquiry in the Structural Materials Testing Laboratory of the United States Geological Survey.

There could well be a further great enlargement of the field of industrial research in special industries through the initiative and support of national trade associations, to the great benefit of their membership. The American Paper and Pulp Association, for example, should subsidize studies in the utilization of waste sulphite liquors, the paper-making qualities of unused woods and fibers, the hydration of cellulose, new methods of beating the yields from rags, the proper use of alum and so on. The American Brass Founders' Association could not do better than initiate investigations into zinc losses, the physical properties of alloys, and the production of alloys to specifications defining the properties desired, the application of the electric furnace to the industry and the preparation of new alloys by electric or other methods. A similar opportunity knocks at the door of the American Foundrymen's Association. Some few associations like those of the bakers and the laundrymen are already active to good purpose; others, like the Yellow Pine Lumber Manufacturers' Association, are aroused, but to the great majority of those

powerful organizations, research is still an academic question to be discussed by their members individually if they so choose. Every industry has, however, its broad research problems, and its points especially vulnerable to research attack, among which it should be easy to select those of general interest to the industry as a whole.

There are in the country many analytical, testing and commercial laboratories, and, in most of these, special researches are conducted for clients, often with gratifying results. It is to be regretted, however, that there is not a more general appreciation among commercial chemists of the scale and quality of equipment and organization essential for really effective industrial research. As this broader viewpoint is attained, and the engineer's habit of mind acquired, we may expect a great extension of independent research, and the cessation of complaint regarding the trend of prices for analysis.

Among the relatively few private or incorporated laboratories with highly organized staff, and adequate special equipment, should be mentioned those of the Institute of Industrial Research at Washington, which has done notable work on the corrosion of metals, paint technology, canning, road material, cement and special mill problems; the electrochemical laboratories of FitzGerald and Bennie at Niagara Falls, which have so successfully specialized on the construction and operation of electric furnaces to meet the requirements of special processes and products; the ore sampling and treating plant of Ricketts and Banks, and the Pittsburgh Testing Laboratory.

Industrial research is applied idealism: it expects rebuffs, it learns from every stumble and turns the stumbling block into a stepping stone. It knows that it must pay its way. It contends that theory springs from practise. It trusts the scientific imagination, knowing it to be simply logic in flight. It believes with F. P. Fish, that, "during the next generation—the next two generations—there is going to be a development in chemistry which will far surpass in its importance and value to the human race, that of electricity in the last few years. A development which is going to revolutionize methods of manufacture, and more than that, is going to revolutionize methods of agriculture," and it believes with Sir William Ramsay that "The country which is in advance in chemistry will also be foremost in wealth and general prosperity."

With these articles of faith established in our thought, let us consider where they lead us. Within the last few days Frank A. Vanderlip, than whom no one speaks with more authority upon financial matters, has told the assembled representatives of the electrical industries that they are facing a capital requirement of $8,000,000 a week for the next five years—a total within that period of $2,000,000,000. As chemists, we are ourselves entering upon an era in which the capital demands of industries now embryonic or not yet conceived will in the not distant future be equally insistent and even more insatiable. Have we as chemists given a thought to this aspect of the development of our science, or planted the seeds of the organization which may some day cope with it? In the electrical and other established engineering professions, it is significant that the great industrial applications of the sciences involved have been in large part due to the activities of firms and organizations like Stone and Webster, J. G. White & Co., Blackwell, Viehle & Buck and the United Gas Improvement Co., which, by an orderly but inexorable evolution, passed from the status of engineers to that of engineers and bankers. Our own profession has

not yet evolved the chemist and banker, but such an evolution, or at least the close alliance of chemistry and banking is a fundamental prerequisite if the results of industrial research are to find their full fruition in America. Let me add that no field within the purview of the banker is more ripe for tillage or capable of yielding a richer harvest.

We need, however, to lead the banker to the chemical point of view, and even more do we ourselves require to be taught the financial principles involved in the broad application of chemistry to industry. To the ideals of service which inspire our profession, and which are so finely exemplified in Cottrell and made effective in the research corporation, we should add a stronger impulse to direct personal initiative in affairs. We shall need for years to prosecute a vigorous campaign for a better understanding by the general public of what chemistry is and what research is. The popular imagination is ready to accept any marvel which claims the laboratory as its birthplace, but the man in the works still disbelieves that two and two in chemical nomenclature make four. We need a multiplication of research laboratories in special industries, each with an adequate staff of the best men obtainable and an equipment which gives full range to their abilities. In nearly every case this equipment should include apparatus of semi-commercial size in which to reduce to practise the laboratory findings. Nothing is more demoralizing to an industrial organization, and few things are more expensive, than full-scale experimentation in the plant.

These laboratories should each be developed around a special library, the business of which should be to collect, compile and classify in a way to make all instantly available, every scrap of information bearing upon the materials, methods, products and requirements of the industry concerned. Modern progress can no longer depend upon accidental discoveries. Each advance in industrial science must be studied, organized and fought like a military campaign. Or, to change the figure, in the early days of our science, chemists patrolled the shores of the great ocean of the unknown, and seizing upon such fragments of truth as drifted within their reach, turned them to the enrichment of the intellectual and material life of the community. Later they ventured timidly to launch the frail and often leaky canoe of hypothesis and returned with richer treasures. To-day, confident and resourceful, as the result of many argosies, and having learned to read the stars, organized, equipped, they set sail boldly on a charted sea in staunch ships with tiering canvas bound for new El Dorados.

Arthur D. Little

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## *SOME PALEONTOLOGICAL RESULTS OF THE SWEDISH SOUTH POLAR EXPEDITION UNDER NORDENSKIOLD*

Since the days of Sir Joseph Hooker's article[1] on southern pines which was published in 1845 there has been much speculation regarding Antarctica as a center of evolution and radiation of both floras and faunas and as affording a theater for the interchange of floras and faunas between South America, Africa and Australia.[2] Outside of the deductions based on the geographical distribution of the existing biota of these three regions practically no facts have been available from Antarctica itself, particularly regarding the extinct forms of this great ice-covered land-mass.

Antarctic exploration has been very active during the past decade and popular as well as scientific interest has been greatly heightened

[1] *Jour. Bot.*, Vol. 4, 1845, p. 137.

[2] See recent summary by Hedley in *Proc. Linn. Soc. Lond.*, reprinted in Smithsonian Report for 1912, pp. 443–453, 1913.

of late by Captain Amundsen's discovery of the South Pole and by the tragic fate of Captain Scott and his little band of heroes after they too had penetrated to the pole. It has, therefore, seemed worth while to bring together a brief account of the recently described paleontological discoveries, naturally laying particular emphasis on those of a paleobotanical nature.

The hardship under which Gunnar Andersson collected the splendid Mesozoic flora of Graham Land and the bag of geological specimens which Scott's party dragged along to their last camp bear eloquent testimony to a devotion not only to the ideal of science, but also to that of manhood that should be an inspiration alike to scientist and to layman.

Ten years ago not a single fossil plant was known from the 14½ million square miles of the earth's surface south of latitude 60° which roughly marks the boundary of the Antarctic continent, in fact it was not certainly known that Antarctica was really a continent and not merely an archipelago.

The paleobotanical results to be noted presently are due almost entirely to the expedition led by Dr. Otto Nordenskiöld,[3] nephew of the discoverer of the Northeast passage, and to Captain Larsen of his ship the *Antarctic*. They reached the South Shetlands in January, 1902, and the party spent two winters on Snow Hill Island, 64° 25′ S. Petrified wood and Cretaceous and Tertiary plants were collected on Seymour and Snow Hill Islands while J. Gunnar Andersson who with Lieutenant Duse was forced to pass an unprepared-for winter at Hope Bay, collected the fine series of Jurassic plants that form the basis for Halle's memoir to be discussed presently.

Captain Larsen[4] during his voyages with the *Jason* in 1892–1894 had found fossil mollusca and petrified wood on Seymour Island, as had also the English expedition, and this was one of the principal factors in deciding upon the itinerary of Nordenskiöld's expedition. The results more than justified the expectations of the explorers, for in addition to the collection of Jurassic, Cretaceous and Tertiary plants they have brought back extensive collections of Upper Cretaceous invertebrates, of Tertiary invertebrates and vertebrates, the latter including the remains of five new genera of birds and a species of *Zeuglodon*.[5]

The paleobotanical materials were turned over to Professor Nathorst, the veteran student of Arctic fossil floras, who published two preliminary announcements, the first in the *Comptes rendus* of the French Academy for June 6, 1904, entitled *Sur la flore fossile des regions antarctiques* and the second before the International Geologic Congress at Mexico City in 1906, entitled "On the Upper Jurassic Flora of Hope Bay, Graham Land."

Pressure of other work entailed his turning over the materials to other specialists for final elaboration and we now have a memoir by Dusén on the Tertiary floras, one by Gothan on the fossil woods, some of which are of Upper Cretaceous age, and a third by Halle on the Mesozoic flora.

The Jurassic flora from Hope Bay is the most extensive of these three floras and in some respects the most interesting.

Halle's memoir of the latter flora[6] is one of the most careful examples of systematic paleobotanical work that has appeared in recent years, maintaining an eminently sane point of view, and occupying middle ground between the pronounced conservatism of the English students of Mesozoic floras and the unduly sanguine work of some of the older paleobotanists, such as Saporta or Heer.

Although the method has been criticized,[7] Halle maintains, quite rightly it seems to me, that it is better to describe new species than

[3] See article in *Geogr. Jour. Lond.*, Vol. 23, February, 1904, by Nordenskiöld and others, giving a general account of the expedition. Reprinted in Smithsonian Report for 1903, pp. 467–479, pl. 1, 1904.

[4] Larsen, *Geogr. Jour.*, Vol. 4, 1894, p. 333.

[5] A summary of the results and a preliminary account of the geology is given by J. Gunnar Andersson, *Bull. Geol. Inst., Upsala*, Band 7, 1906, pp. 19–71, Pl. 1–6.

[6] A brief review by F. H. Knowlton appeared in SCIENCE, Vol. 37, pp. 763–764, May 16, 1913.

[7] Seward, *New Phyt.*, Vol. 12, 1913, p. 188.

to identify doubtful material with previously described forms, especially when widely separated either geologically or geographically, since it is subsequently much easier to reduce a new name to synonymy than to disentangle a complex agglomeration that gets distributed through the literature under a single name.

The Jurassic flora was found in a hard slaty matrix preserving large-sized and clearly outlined specimens, but not showing the venation characters especially well. The collection embraces over sixty forms, of which, however, nearly a score have not been given specific names. The Equisetales are represented by *Equisetites approximatus* sp. nov., a form closely resembling *E. rajmahalensis* Schimper from the Indian Jurassic as well as *E. Duvalii* Saporta. The Hydropterideæ are represented by well-preserved specimens of the wide-spread Jurassic species *Sagenopteris paucifolia* (Phillips) Ward. Fern fronds are abundant, twenty-five different species being represented. These include a *Dictyophyllum;* the wide-ranging Jurassic *Todites Williamsoni* (Brongniart) Seward; seven forms referred to *Cladophlebis,* four being wide-ranging Jurassic forms and two being new. Three fern species are identified with well-known forms of *Coniopteris;* eight are referred to the form-genus *Sphenopteris,* four of these being new; two new species are described in *Scleropteris;* and the doubtful genera *Pachypteris* and *Thinnfeldia* are retained with the ferns. The *Pachypteris* is considered to be identical with *P. dalmatica* F. v. Kerner, a European Cenomanian species. The *Thinnfeldia,* which is described as new and compared with *T. rhomboidalis* Ettings., *T. indica* Feistm., and *T. speciosa* (Ettings.), Seward, is not unlike *T. granulata* Fontaine from the Patuxent formation (Lower Cretaceous) of Virginia.

Fronds of the Cycadales, which are not especially common in the Arctic Jurassic, constitute a prominent element in the Hope Bay flora, some nineteen species being represented. These include a large and abundant entire type of *Nilsonia* which Halle described as a new species. Except for the fact that our east American *Nilsonia densinerve* (Font.) Berry seems to have been rarely entire and the Antarctic form constantly so, there is a similarity, almost amounting to identity, between the two, a fact which Halle has not failed to notice. Three forms are referred to Seward's new genus *Pseudoctenis,* which is close to the American Lower Cretaceous genus *Ctenopsis* Berry. Four new species are instituted in *Zamites* for types of fronds often referred to the genus *Ptilophyllum.* Six forms are referred to *Otozamites* and there is a new species of *Williamsonia,* a form identified as *Ptilophyllum,* and an unnamed species of *Cycadolepis.*

The coniferous remains are abundant and include representatives of fifteen species referred to the genera *Araucarites, Pagiophyllum, Brachyphyllum, Sphenolepidium, Conites, Stachyopitys* and *Elatocladus.* This is the least satisfactory part of the memoir, but as the genera of fossil coniferophyta are in an almost hopelessly tangled state the author can not be blamed for any shortcomings in this respect. The genus *Elatocladus* with four species is proposed as a convenient term for sterile shoots of the radial or dorsiventral type, which are not certainly referrable to established genera with known fruiting characters. Like all form-genera this is confessedly artificial and it may well be doubted if in a world where all generic and specific determinations of recent as well as fossil forms contain a more or less varying personal equation whether it helps to clarify a complex situation.

Forms conspicuously wanting are *Podozamites* and all traces of *Ginkgoales* represented in northern floras by several genera such as *Ginkgo, Baiera, Phœnicopsis, Czekanowskia,* etc. These are also wanting or only doubtfully represented in the fossil floras of India. The abundant *Zamites* and *Otozamites* fronds are also consistently smaller types than in northern floras. There are absolutely no traces of Angiosperms.

Hope Bay is in latitude 63° 15′ S. and it is, therefore, the most southerly point furnishing a flora of Jurassic age.[8] It is, therefore, re-

[8] Members of the Shackleton Expedition collected petrified wood and recorded the occurrence of a coal seam in latitude 80° S.

markable, considering its remoteness, that the flora should show so great a resemblance to that of the English Oolitic flora or the Upper Gondwana flora of India. It contains a number of forms identical with Arctic, Eurasiatic and North American Jurassic plants and adds another link in the chain of facts showing the cosmopolitan character of Jurassic floras. As regards the exact age of the Hope Bay flora Halle concludes that there is no reason to believe that it is in any considerable degree older or younger than other floras known to be of Middle Jurassic age. It seems to me that if anything it is younger, especially if the identification of *Pachypteris dalmatica* is certain. The resemblance of some of the Antarctic forms to American Lower Cretaceous species and the identification of Wealden forms, even if somewhat uncertain, is entitled to the weight which should always be given to new as against surviving types.

Regarding Jurassic climatic conditions the present contribution is of vast importance. Collected in a glaciated region where there are only two existing species of vascular plants, it presents no intrinsic evidence that would have prevented it having come from England, Italy or India. There is no dwindling of the forms or reduction of certain groups as some authors have maintained to be the case in high northern latitudes. This is all the more interesting since the recent discovery of the *Glossopteris* flora in the geographically near Falkland Islands shows that the two floral and climatic provinces of the closing Paleozoic—the northern or cosmopolitan and the *Glossopteris-Gangamopteris* type, found expression in the far south, but in terms of geologic time were of short duration.

All of Snow Hill Island and the larger southwestern part of Seymour Island, as well as a considerable area of the eastern part of Ross Island around Cape Hamilton, which is just across Admiralty Sound from Snow Hill Island, is made up of Upper Cretaceous strata, mostly sandstones. These contain rich faunas of which the ammonites, abounding in individuals and species, have been described by Professor Kilian of Grenoble.[8] The Pelecypoda, Gastropoda and Annelida have been described by Wilckens;[9] the Brachiopoda by Buckman;[10] the Echinoidea by Lambert;[11] the corals by Felix;[12] the Foraminifera by Holland,[13] and the fishes by Smith Woodward.[14] Altogether these contributions add an imposing array of Cretaceous fossils to Antarctica. The faunas indicate an older and a younger Cretaceous series of which the latter is much the richer in both species and individuals. The older is considered to correspond approximately to the Ootator group of India of lower Cenomanian age, while the younger is Senonian and shows considerable resemblance to the fauna of the Quiriquina beds of southern Chile, and to marine beds in southern Patagonia[15] made known by Steinmann and Wilckens.

Impressions of a single Cretaceous plant were found in a Nunatak group near the middle of Snow Hill Island. This has been determined by Professor Nathorst to be close to *Sequoia fastigiata* (Sternb.) Heer, a species of conifer that is not uncommon in the Cenomanian of Europe, occurring also from the Cenomanian upward into the Senonian of Greenland and also present in the Tuscaloosa formation of Alabama. It is described and figured in Halle's memoir on the Jurassic flora.

Some of the petrified woods described by Gotham come from the Upper Cretaceous, but as there is some doubt as to the horizons from which the specimens came the Cretaceous and Tertiary woods may be considered together.

Fossil wood was found on both Seymour

[8] Kilian and Reboul, "Les Céphalopodes Néocrétacés," *Wissen. Ergeb.*, Band 3, Lief 6.

[9] *Ibid.*, Lief 12.

[10] Lief 7.

[11] Lief 11.

[12] Lief 5.

[13] Lief 9.

[14] Lief 4.

[15] Wilckens has proved that the southern Patagonian beds are synchronous with the Rosa and Salamanca beds of central and northern Patagonia and included them all in what he calls the San Jorge formation.

and Snow Hill Islands. Gothan, who has described the fossil woods, has differentiated six forms, all new. Five of these are given specific names and all of the determinable forms are from Seymour Island. They are as follows: *Phyllocladoxylon antarcticum, Podocarpoxylon aparenchymatosum, Dadoxylon (Araucaria) pseudoparenchymatosum, Laurinoxylon uniseriatum, Laurinoxylon?* sp., *Nothofagoxylon scalariforme.* As I have already mentioned, there is, unfortunately, some uncertainty as to their exact age. Part of the specimens representing the *Phyllocladoxylon* are Tertiary and the balance are Upper Cretaceous or Tertiary. The *Podocarpoxylon* is given as Tertiary and the balance may be either Upper Cretaceous or Tertiary. In either case they show that types now regarded as South American or Australasian were much more wide-spread in the early Tertiary or late Cretaceous. It is of some interest to find structural remains of Araucarieæ, Lauraceæ and *Nothofagus,* since these three types are also represented in the leaf impressions studied by Dusén.

The northeastern portion of Seymour Island is made up of Tertiary beds. These are mostly marine calcareous sandstones, but with some tuffs containing augite-porphyrite. In these sandstones Nordenskiöld discovered leaf impressions which Nathorst reported upon in his brief paper of 1904.[16] They have been monographed by Dusén.[17] The material is abundant but very fragmentary. Dusén recognizes 87 different forms, of which only 25 receive specific names. Both the results and their method of presentation are open to criticism. While Dusén has brought to the work an extensive acquaintance with the existing flora of South America, it does not appear that he has an equal knowledge of paleobotanical literature and there is a tendency to see an undue resemblance to the existing flora he seems to know best.

There are 26 different *Phyllites* sp., some of which are Angiosperms and some Gymnosperms. Of the 37 different ferns only nine are identified and we are treated to the abominable array of 10 *Sphænopteris* sp. and 18 *Pecopteris* sp., both form-genera that should really be reserved for Paleozoic fern-like remains, *Sphenopteris* being partly, and presumably wholly, Pteridospermic and *Pecopteris* being filicalean. With the exception of a *Fagus* previously described by Dusén from the Straits of Magellan and a *Nothofagus* described by Engelhardt from the same region, all of the named species are new to science. They include forms in the following genera: *Miconiiphyllum, Lauriphyllum, Mollinedia, Araucaria, Polypodium, Asplenium, Alsophila, Dryopteris, Caldcluvia, Laurelia, Drimys, Lomatia, Knightia, Fagus, Nothofagus* and *Myrica.*

The first eight of these have their closest affinities with forms in the existing subtropical flora of southern Brazil, while the balance resemble existing species of West Patagonia and southern Chili. Dusén concludes that this mixed character is due to differences in altitude at which the Seymour Island plants grew. This may well be the case, but on the other hand the author is apparently unaware of the polar extension of more equatorial climates with a mixing of types since associated with temperate or tropical conditions that occurs in the early Tertiary, or to the general lack of well-defined climatic zones in the history of the earth throughout geological times. Many attempts have been made to emphasize the fact that climates like that of the present or the Pleistocene, of which the present is really a part, or of *Glossopteris* time, or of earlier glacial periods, were the exception and not the rule when all geological time is considered. The consequent lack of extreme cold in the Tertiary when accompanied by sufficiently humid conditions would answer for the Seymour Island Tertiary flora equally as well as an altitudinal zonation.

According to Dusén this flora is typically South American, with only slight relationships to the flora of New Zealand (cf. *Laurelia*) and Australia (cf. *Knightia*). This is perhaps what would be expected since both tectonically and petrographically Graham Land

[16] *Comptes rendus, loc. cit.*

[17] Lief 3, 1908.

seems to represent a southward extension of the Andean axis. At the same time, it seems to me that a more critical analysis of the flora by a student qualified to compare it with the living and fossil floras of Australia, New Zealand and with more northern Tertiary floras, would bring out a good many significant features that remain hidden in Dusén's work.

Regarding the age of the Seymour Island Tertiary, Dusén, relying on comparisons with the fossil floras from the Straits of Magellan and Chili and on the affinities of the associated Mollusca, as communicated by Wilckens, concludes that it is late Oligocene or early Miocene. I would be much more inclined to consider its age as somewhat older and corresponding roughly to that of the Arctic Tertiary floras, which in turn are contemporaneous or slightly younger than those in lower latitudes that are marked by that northward extension of tropical climates which commences in the early Eocene and culminates in this country in the Vicksburg and Apalachicola groups.

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## SCIENTIFIC NOTES AND NEWS

SIR WILLIAM OSLER has accepted an invitation to deliver the principal address at the opening of the James Buchanan Brady Urological Clinic of the Johns Hopkins Hospital.

THE annual Huxley Memorial Lecture of the Royal Anthropological Institute will be delivered on November 14, by Professor W. J. Sollas, F.R.S., who will take as his subject "Paviland Cave."

THE council of the Royal Meteorological Society has awarded the Symons gold medal to Mr. W. H. Dines, F.R.S. The medal will be presented at the annual meeting of the society on January 21.

THE Baly medal of the Royal College of Physicians of London has been presented to Dr. John Scott Haldane, F.R.S., reader in physiology in the University of Oxford. The medal was founded by Dr. Frederic Daniel Dyster in 1866 in memory of William Harvey, and is awarded every alternate year. The last five recipients have been Professor J. N. Langley, F.R.S. (1903), Professor Pawlow, of St. Petersburg (1905), Professor E. H. Starling, F.R.S. (1907), Professor Emil Fischer, of Berlin (1909), and Professor W. D. Halliburton, F.R.S. (1911).

ON the recommendation of the committee on the award of the Hodgkins prize of $1,500 for the best treatise "On the Relation of Atmospheric Air to Tuberculosis," which was offered by the Smithsonian Institution in connection with the International Congress on Tuberculosis held in Washington in 1908, the institution announces that the prize has been equally divided between Dr. Guy Hinsdale, of Hot Springs, Virginia, for his paper on "Tuberculosis in Relation to Atmospheric Air," and Dr. S. Adolphus Knopf, of New York City, for his treatise on the "Relation of Atmospheric Air to Tuberculosis." The members of the committee on award were: Dr. William H. Welch, John Hopkins University, Baltimore, Md., *chairman;* Dr. Hermann M. Biggs, New York City; Professor W. M. Davis, Cambridge, Mass.; Dr. G. Dock, Washington University Medical School, St. Louis, Mo.; Dr. Simon Flexner, Rockefeller Institute for Medical Research, New York City; Dr. John S. Fulton, Baltimore, Md., and Brig. Gen. George M. Sternberg, U. S. A. (retired), Washington, D. C.

PROFESSOR R. BURTON-OPITZ, of the College of Physicians and Surgeons, Columbia University, has been elected president of Alpha Omega Alpha, the honorary medical society, which now has chapters in the seventeen most representative medical colleges.

MR. H. N. BAKER, assistant superintendent of the National Zoological Park at Washington, has resigned to become superintendent of the Boston Zoological Garden.

DR. ROBERT MATHESON, formerly provincial entomologist of the Province of Nova Scotia, has recently resigned to accept the position of investigator in entomology in Cornell Agricultural Experiment Station, Ithaca, N. Y.

Mr. Bascombe Britt Higgins, Ph.D. (Cornell, '13), has been appointed botanist and plant pathologist of the Georgia Experiment Station. Dr. Higgins began his work in Georgia early in October.

Professor George V. N. Dearborn, of the Tufts College Medical and Dental School, has been appointed consulting physiologist to the Forsyth Dental Infirmary, Boston.

W. J. Wintemberg has been appointed preparator in archeology in the Geological Survey Branch of the Department of Mines, by the Civil Service Commission of Canada.

The council of the Victoria Institute has appointed Mr. E. Walter Maunder to the secretaryship of the institute, vacant by the death of Mr. F. S. Bishop. Mr. Maunder will retire on November 4 from the Royal Observatory, Greenwich, where he has been superintendent of the Solar Department for 40 years.

Professor C. G. Barkla, recently elected to the chair of natural philosophy in the University of Edinburgh, gave his inaugural lecture on October 16, Principal Sir William Turner presiding. The subject of the address was, "What we know of Electricity."

The Bradshaw Lecture before the Royal College of Physicians of London was delivered on November 4 by Dr. T. R. Glynn, professor of medicine in the University of Liverpool, whose subject was "Hysteria in some of its aspects." Two Fitz-Patrick Lectures were announced to be delivered on November 6 and 11 by Dr. C. A. Mercier, on "Astrology in medicine."

Dr. Hermann Aron, who made important contributions to electrial engineering, has died at the age of sixty-eight years.

M. Charles Tellier, the inventor of the cold storage system, has died at eighty-six years of age.

The U. S. Civil Service Commission announces an examination for assistant in agricultural technology, for men only, on December 3, to fill vacancies in the Bureau of Plant Industry, Department of Agriculture, at salaries of from $1,250 to $2,250.

In connection with the sixth international congress of mathematicians, to be held in Stockholm in 1916, King Gustav V. of Sweden has founded a prize, consisting of a gold medal bearing a portrait of Weierstrass and a cash sum of 3,000 crowns, for the best contribution to the theory of analytic functions.

The annual joint meeting of the American Anthropological Association and the American Folk-lore Society will be held in the American Museum of Natural History, New York City, December 29–31. Titles of papers and abstracts should be sent not later than December 1 to Professor George Grant MacCurdy, Yale University Museum, New Haven, Conn., who is responsible for the joint program. The program will be mailed to members about the tenth of December.

The American Mathematical Society has accepted the invitation of Brown University, extended through the committee on the celebration of her one hundred and fiftieth anniversary to hold its fall meeting at Brown University in September, 1914.

The *London Times* says that Dr. Mawson and his comrades, who were practically marooned in the Antarctic by the sudden onset of winter last year, are still stranded. Like nearly every other polar expedition of recent years, this exploration party started south without having the definite assurance that it would receive sufficient financial support to enable it to complete its undertaking. The Australian state governments voted Dr. Mawson £20,000 and the commonwealth government £5,000, but these amounts, together with other public and private donations, have not covered the cost of the expedition. At the present moment its liabilities amount to about £11,000 and its assets total some £5,000. It requires the difference, £6,000, to bring the members of the expedition back to Australia, when the relief ship *Aurora* can reach them. Appeal has been made to the commonwealth government by Professor David, of Sydney, for a further vote of £5,000, and it is hoped that the extra £1,000 will be raised by private subscriptions.

THE Philadelphia Pathological Society will hold at the College of Physicians, on November 20, at 8:15 P.M., a symposium on the subject of "Physical Growth and Mental Development." The speakers will be Dr. H. H. Donaldson, of the Wistar Institute, "Studies on the Growth of the Central Nervous System"; Professor Bird T. Baldwin, of Swarthmore College, "The Normal Child; Its Physical Growth and Mental Maturity," and Professor Lightner Witmer, of the University of Pennsylvania, "Children with Mental Defects Distinguished from Mentally Defective Children." The discussion to be opened by Dr. H. H. Goddard, of the New Jersey Training School, Vineland, N. J., Dr. Charles Burr, of Philadelphia, and Professor J. H. Leuba, of Bryn Mawr College.

WE learn from the report in the London *Times* that the International Tuberculosis Conference held its first meeting in the Lower House of the Prussian Diet, Berlin, on October 23. Dr. Franz Bumm presided in the absence of M. Léon Bourgeois. The conference was welcomed by the secretary of state for the Imperial Ministry of the interior, Dr. Delbrück, who observed that the conference was meeting at the place where the international organization was founded eleven years ago under the patronage of the German empress. It now embraced the whole world and united the nations in a common labor for humanity. Speaking of the fight against tuberculosis in Germany, Dr. Delbrück said that there were now 147 sanatoria, with 15,278 beds. There were 103 institutions, with more than 9,000 beds, for children threatened with tuberculosis, 114 forest sanatoria, and 17 forest schools. Dr. Delbrück called special attention to the movement for the addition of wings to hospitals rather than for the building of sanatoria, and said that there were now more than 200 tuberculosis wings of general hospitals in Germany. He observed that England held the lead in the matter of notification, and referred to the new movement in Germany for the isolation of cases in an advanced stage of the disease. This point was endorsed by the medical officer of health for Berlin, who announced that a special tuberculosis hospital, with 1,000 beds, is to be built here. Dr. Delbrück said that within about fifteen years the mortality due to tuberculosis had declined by one third in England, Germany, France, Belgium and the United States, and by one fifth in Austria, Switzerland and the Netherlands.

*Nature* states that in his evening lecture to the British Association at Birmingham on September 16, Dr. Smith Woodward took the opportunity of replying to Professor Arthur Keith's recent criticisms on his reconstruction of the Piltdown skull. It will be remembered that Dr. Woodward regarded the mandible as essentially that of an ape, and restored it with ape-like front teeth, while he determined the brain-capacity of the skull to approach closely the lowest human limit. Professor Keith, on the other hand, modified the curves of the mandible to accommodate typically human teeth, and reconstructed the skull with a brain-capacity exceeding that of the average civilized European. Fortunately, Mr. Charles Dawson has continued his diggings at Piltdown this summer with some success, and on August 30, Father P. Teilhard, who was working with him, picked up the canine tooth which obviously belongs to the half of the mandible originally discovered. This tooth corresponds exactly in shape with the lower canine of an ape, and its worn face shows that it worked upon the upper canine in true ape fashion. It only differs from the canine of Dr. Woodward's published restoration in being slightly smaller, more pointed and a little more upright in the mouth. Hence, there seems now to be definite proof that the front teeth of *Eoanthropus* resembled those of an ape, and its recognition as a genus distinct from *Homo* is apparently justified. The association of such a mandible with a skull of large brain-capacity is considered by Dr. Woodward most improbable, and he has made further studies of the brain-case with the help of Mr. W. P. Pycraft, who has attempted a careful reconstruction of the missing base. Dr. Woodward now concludes that the only alteration necessary in his original model is

a very slight widening of the back of the parietal region to remedy a defect which was pointed out to him by Professor Elliot Smith when he first studied the brain-cast. The capacity of the brain-case thus remains much the same as he originally stated, and he maintains that Professor Keith has arrived at a different result by failing to recognize the mark of the superior longitudinal sinus on the frontal region and by unduly widening that on the parietal region. It is understood that Mr. Dawson and Dr. Woodward will offer an account of the season's work to the Geological Society at an early meeting, and Professor Elliot Smith will include a detailed study of the brain-cast of *Eoanthropus* in a memoir on primitive human brains which he is preparing for the Royal Society.

Leonardo da Vinci left a number of anatomical drawings with descriptions which are now in the Royal Library at Windsor, after lying hidden in the Ambrosia Library, Milan, for centuries. The *British Medical Journal* states that photographs of these, with English and German translations of the descriptions, have been prepared by Ove C. L. Vangensten, A. Fonahn and H. Hopstock, and published by Jacob Dybwad, of Christiania. Dr. Hopstock is prosector of anatomy in the University of Christiania, where Dr. Fonahn is professor of the history of medicine, and Mr. Vangensten, professor of Italian. The first volume ("Quaderni d'Anatomia," I.), published in 1911, contains 13 folios, 22 pages in facsimile (collotype), and 70 designs. The subjects illustrated are respiration, the alternating motions of the diaphragm and the muscles of the abdomen, together with the passage of the food through the alimentary canal, and the heart. A special volume on the heart ("Quaderni d'Anatomia," II.), containing 24 folios, 33 pages in facsimile (collotype) and 240 designs, was published in 1912. The third volume, which appeared in September of the present year, consists of 12 folios, 20 pages in facsimile (collotype), dealing with the organs of generation. The remainder of the hitherto unpublished Windsor papers will follow, one volume appearing annually in September. The whole work will comprise six volumes. The Professor Voss prize has been awarded to the editors by the University of Christiania.

## *UNIVERSITY AND EDUCATIONAL NEWS*

There is under construction at Smith College a biological hall for which the trustees have appropriated $140,000. Hitherto the departments of physics, zoology and botany have done most of their work in Lilly Hall. With the completion of the new building this hall will be left entirely to physics.

A second gift of $10,000 from Mr. Melville H. Hanna, to Union College, is announced.

Lafayette College has received $90,000 for a chapel from a donor whose name is withheld.

An anonymous friend has presented to the University of Leeds £10,000 for the erection of a school of agriculture.

By the will of the late Henry Follett Osler the University of Birmingham is to receive the sum of £10,000, with a prospective share in the residuary estate.

Cornell University Medical College opened on October 1, with an enrollment as follows: For the degree of M.D.: first year, 36; second year, 32; third year, 20; fourth year, 20; special students (work not leading to the degree M.D.), 5; for the degree of Ph.D., 2; for the degree of M.A., 2; making a total of 117. All students now registered, with the exception of those pursuing the combined seven years course leading to the degrees of A.B. and M.D., are graduates of arts or science, or doctors of medicine doing advanced work.

Professor Willard C. Fisher, whose forced resignation from the chair of economics and sociology at Wesleyan on the alleged ground of his views on Sabbath observance will be remembered, has been appointed lecturer on economics at Harvard University for the current academic year.

The trustees of The Ohio State University have made the following promotions: Charles St. John Chubb, Jr., C.E., to be professor of architecture; Dana James Demorest, B.S.C., to be professor of metallurgy; Harry Clifford Ramsower, B.S.C., to be professor of rural

engineering; Carl Bertram Harrop, E.M., to be assistant professor of ceramic engineering; Aubrey Ingerson Brown, M.E., to be instructor in mechanical engineering. Mr. Franklin Wales Marquis, M.E., of the University of Illinois, has been appointed professor of steam engineering to succeed Mr. E. A. Hitchcock, M.E., who resigned last spring to accept a position as sales engineer with E. W. Clark & Co.

MR. G. D. HORTON, M.S. (Yale, '13), has been appointed instructor in bacteriology in the Oregon Agricultural College.

MISS E. M. PINNEY, formerly instructor in zoology, at the University of Kansas, has been appointed demonstrator in biology in Bryn Mawr College, to succeed Dr. Harriet Randolph, who is at present in Europe.

THE following appointments have been made at the University of Birmingham: Mr. L. J. Wills, assistant lecturer in geology and geography; Mr. David Brunt, lecturer in mathematics (to succeed Mr. S. B. McLaren); Dr. C. L. Boulenger, reader in helminthology; Mr. H. G. Jackson, assistant lecturer in zoology.

## *DISCUSSION AND CORRESPONDENCE*

### LABELING MICROSCOPIC SLIDES

TO THE EDITOR OF SCIENCE: Two things are absolutely essential to properly prepared microscopic slides; these are permanent labels and cleanliness. I have been interested in two notes that have recently appeared in SCIENCE, namely, one by Zea Northrup in the July 25 issue and, the other, by Ernest S. Reynolds, in the September 12 number. The paper labels usually affixed to the slides of a study or loan collection soon become soiled and the data more or less effaced. To obviate this, several years ago I commenced to use small and very thin paper slips upon which the data were written in "Higgin's Waterproof (Black) India Ink," placed under the cover-glass at one of the angles and in this way mounted with the specimens. I have observed this method in use at several institutions. This technical procedure permits dipping of the slides into water and their subsequent cleaning and polishing with a soft cotton cloth. The covering of the India ink label with balsam and cover-glass, as recommended by Reynolds, is an excellent method. I do not think it wise to trust to "merely printing or writing the necessary description upon the slide with India ink" as recommended by Northrup. A person can not always be sure that the writing surface is free from oily matter. Disappointment frequently attends this procedure. For some time I have used the following method: The essential data are neatly written or printed across one end of the slide as close as possible to the cover-glass and, after the ink has dried, a thin layer of Canada balsam in xylol—two to one—is painted with a camel's hair brush across the slide over the label. After the balsam has become thoroughly hardened the slide can be dipped into cold water and cleaned with a soft cotton cloth, as above. Care should at all times be taken to avoid having the slides come in contact with alcohol or xylol. Should such a thing happen the surface of the balsam can be restored by reapplication of the thin balsam. The first slide of a series or set should bear a paper label as well as the ink inscription.

FRANK E. BLAISDELL

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### A NORTHERLY RECORD FOR THE FREE-TAILED BAT

ON the morning of August 15, 1913, I picked up a live male free-tailed bat (*Nyctinomus mexicanus* Saussure) on the pavement on the main business street of Lincoln, Nebraska. It was huddled against the wall at the corner of what is probably the most brilliantly lighted building on the street where it was presumably attracted by the illumination the previous night. The specimen is now in the author's collection where it has been seen by Mr. Vernon Bailey, of the U. S. Biological Survey, who has verified the determination.

This bat normally occurs in the United States in the Lower Sonoran fauna of Texas,

Arizona and California. Four specimens were taken at Newcastle, Colorado, on July 16, 1907, by E. R. Warren,[1, 2] the locality being situated on a narrow tongue of Upper Sonoran almost surrounded by Transition but connected by a belt of the Upper Sonoran across Utah with the Lower Sonoran in Arizona, part of the regular habitat of the species.[2] A free-tailed bat, referred to this form, was collected at Manhattan, Kansas, in 1884, by Dr. C. P. Blachly.[3] This latter locality is Carolinean, but is not decidedly distant from the Austro-riparian of the Lower Austral zone of southern Kansas and is connected by this with the lower Sonoran fauna in Oklahoma (and possibly in south central Kansas, locally), which latter area is an unbroken northward extension of the Lower Sonoran of Texas where the free-tailed bat is abundant.[4] It seems likely that the Manhattan individual reached Kansas from Texas by this course across Oklahoma and the Lincoln occurrence is probably due to a still more northward extension of the same route, although Lincoln is about two hundred and fifty miles from the boundary of the Lower Austral zone. Possibly the excessive heat and dryness of the past summer in Kansas and southern Nebraska had something to do with the appearance of this bat of the far southwest at a locality so distant from its normal range.

John T. Zimmer
University of Nebraska,
Lincoln, Nebr.,
September 12, 1913

## SCIENTIFIC BOOKS

*Problems of Life and Reproduction.* By Marcus Hartog. G. P. Putnam's Sons. 1913. Pp. 382, 41 text figures.

This volume consists of a series of eleven chapters dealing for the most part with cytological questions relating to the mechanism of heredity, but in part also with general subjects, such as the teaching of nature study. It is, indeed, a collection of biological and philosophical essays published during the period from 1892 to 1910 and here reworked and modernized, to a degree, by interpolation or rewriting. There is lacking any sustained theme except such as is furnished by the consideration of vital processes in some form.

The work was first conceived as a general treatise on reproduction for the non-scientific public, but in its present form, although a reprint of articles already published, is evidently again addressed largely to scientists. If this were not so it would be little read, for there is no lack of technical expressions and the author rarely resists the temptation to increase the number of these by the transformation of common terms into Latin forms.

The attitude of the author is controversial and he announces in the preface that he has "not hesitated to use all the legitimate arms of scientific controversy in assailing certain views." He inveighs strongly against the practise of those writers who present the opinions of any one school as the verdict of biologists in general, but is himself not entirely guiltless of such emphasis on his own conclusions. There appear frequent claims for priority of observation—and especially of theories, not a few of which are the common property of all who generalize. There is apparent the customary European lack of information concerning biological America, the result of which in this case has led the author to explain the processes of fertilization as one bringing about "rejuvenescence." As proof of this he advances the questionable work of Maupas upon the Protozoa in apparent ignorance of the convincing work of Jennings to the contrary. Since some of the essays were written a decade or two ago, there is sometimes lacking a modern viewpoint in the discussion, and even modern evidence is sometimes wanting. The search for ultimate explanations also leads to the assignment of names to conditions or relations which are then regarded as having been explained. Aside

[1] E. R. Warren, "Further Notes on the Mammals of Colorado," p. 85, 1908.

[2] Merritt Cary, "A Biological Survey of Colorado," N. A. Fauna, No. 33, pp. 204–205, 1911.

[3] D. E. Lantz, "Additions and Corrections to the List of Kansas Mammals," *Trans. Kansas Acad. Sci.*, XX., Part II., p. 216, 1907.

[4] Vernon Bailey, "Biological Survey of Texas," N. A. Fauna, No. 25, pp. 215–216, 1905.

from these lapses the author shows strength, vigor and clearness in his method, and however much one may differ from him regarding facts or theories there can be no denial of the individuality or consistency of his views.

Among the diversity of subjects considered certain themes stand out because of emphasis and repetition. Briefly these may be stated as follows: Sexual reproduction is a process for securing rejuvenescence; fertilization effects a cellular reorganization by bringing nuclear material into new cytoplasmic surroundings; reduction is a process to check the indefinite multiplication of chromosomes whose important constituent, the linin, is mechanically divided by the splitting of the chromatin granules; cell division is due to a "new force, mitokinetism," confined to living matter; heredity is not to be explained through the action of any germ plasm, but "can only be elucidated by the light of mental, not material processes"; acquired characters are inherited; such collateral inheritance receives an explanation through the operation of "unconscious memory" according to the theories of Hering and Butler; chemical and physical laws are not sufficient to account for the activities of organisms and we must assume a "vital behavior."

From all of which it is easily seen that Professor Hartog may be classed, philosophically, as a vitalistic Lamarckian. While he strikes vigorous blows in defense of his faith, it must be admitted that he brings little that is new or convincing in proof. It seems impossible not to believe that the reproductive elements are in some way and to some degree affected by conditions external to them, but it brings slight comfort and mental satisfaction to have offered as proof of such a fundamentally important principle the case of two normal children who are supposed to inherit a peculiar habit of writing because a myopic-astigmatic father has developed this as a result of his defective sight. Although the children fail to inherit the structural defect, and the father under corrected vision spontaneously loses the habit at the age of fifteen, they are reported to have it so firmly engrafted upon them as to make its eradication almost impossible. While the writer considers Lankester's logical presumption against the sudden fixation of slight influences through the soma upon the germ cells—in the face of a long adverse phylogenetic history, he does not make a satisfactory answer to it. Much more probable seems the gradual, cumulative effect of a persistent, long-continued influence upon successive generations which finally is able to overbalance the weight of the racial inertia. This would seem to account for the universal failure of experimental proof in support of the theory of inheritance of acquired characters—a theory which seems to be logically correct and which makes such a strong appeal to those who study extensive racial histories.

More scientific is the author's treatment of the problems of maturation and fertilization, although to many there will occur objections that weigh strongly against some of his conclusions. Why so general and apparently important a process as the reduction division should have become established merely to prevent indefinite multiplication of the chromosomes does not receive adequate explanation. Likewise there is no convincing evidence for the conclusion that the linin is the important part of the nuclear substance, for which the chromatin plays merely the mechanical rôle of a dividing agent. Surely Professor Hartog can not have made a careful study of the nucleus during the long and significant growth period preceding the first maturation division or he would not say (p. 138) "whatever be the function of the chromatin in the *'working'* cell, as we may term it, it is evidently less important than its function in the *dividing* cell."

The striking character of the fully established mitotic figure evidently makes a strong appeal to the author, for besides the conclusion just quoted he is led, from the conditions of the bipolar figure, to postulate an entirely new force, mitokinetism, to account for cell division. The whole argument for the new force is based upon the bipolar spindle, yet nothing is more evident than the fact that this

is but the culmination of a long series of changes which have been taking place both within and without the nucleus. All of these changes are ascribed by Professor Hartog to the operation of other physical and vital forces which are finally succeeded by the "new force" which comes into operation upon the establishment of the spindle-shaped figure. The efforts of many who would explain the process of mitosis through the action of various chemical and physical laws have failed through inadequacy of the explanations to meet all the conditions of the process. It does not seem that the author has been more successful by first proclaiming an absolute divorce between nuclear division and cell division and then invoking a new force to complete the broken contract.

For those who enjoy philosophical debate and formal explanations there will be much of interest in Professor Hartog's discussion of vitalism and of heredity through the operation of universal and unconscious memory. Very readable is his appreciation of the work of Samuel Butler. The teacher will find sound argument for natural as opposed to strictly logical methods of teaching in the chapter on "Interpolation in Memory." In the final chapter on "The Teaching of Nature Study" there is much sound pedagogical wisdom and moral support for those who would have such work taught in a way to make it worth the while of the student.

C. E. McClung

*Modern Research in Organic Chemistry.* By F. G. Pope, B.Sc. (Lond.), F.C.S., Lecturer on Organic Chemistry, East London College. New York, D. Van Nostrand Company. 1913. $5\frac{1}{2} \times 7\frac{1}{2}$, Cloth. Pp. xi + 324. With 261 diagrams. Price $2.25 net.

This book is an attempt to bring before the student of chemistry a brief account of the development of some of the more important chapters of organic chemistry. It is the American reprint of the English book with the same title published by Methuen and Co. in London in 1912. It contains an introduction by Professor J. T. Hewitt and nine chapters which have no connection with each other. These chapters are: I., The Polymethylenes; II., The Terpenes and Camphors; III., The Uric Acid or Purine Group; IV., The Alkaloids; V., The Relation between the Color and Constitution of Chemical Compounds; VI., Salt Formation, Pseudo-acids and Bases; VII., The Pyrones; VIII., Ketenes, Ozonides, Triphenylmethyl; IX., The Grignard Reaction.

In each chapter methods of preparation, for the most part synthetical, are given and the reactions of some of the best known representatives of the different classes of compounds are discussed, especially those which are used to determine the structural formulas of the compounds. Throughout the book structural formulas are used almost exclusively. At the end of each chapter there is a bibliography containing a list of the more important papers on the subject matter of the text, so that the student may consult the original articles if he desires to do so. The book is very difficult reading, but for those to whom the original papers are not available and who wish a brief résumé of the researches on which the structure of these compounds is based, it will probably prove useful.

In a book with such a title we should naturally expect something to be said of the researches on the carbohydrates, on the synthesis of indigo and of india-rubber, but no mention is made of these very important chapters of organic chemistry.

W. R. Orndorff

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## *SCIENTIFIC JOURNALS AND ARTICLES*

The October number (Vol. 14, No. 4) of the *Transactions of the American Mathematical Society* contains the following papers:

Maxime Bôcher: "Applications and generalizations of the conception of adjoint systems."

E. J. Wilczynski: "On a certain class of self-projective surfaces."

G. A. Miller: "On the representation groups of given abstract groups."

Dunham Jackson: "On the accuracy of trigonometric interpolation."

G. D. Birkhoff: "On a simple type of irregular singular point."

John McDonnell: "On quadratic residues."

H. M. Sheffer: "A set of five independent postulates for Boolean algebras, with application to logical constants."

Mildred Sanderson: "Formal modular invariants with application to binary modular covariants."

THE opening (October) number of Vol. 20 of the *Bulletin of the American Mathematical Society* contains: "Note on the gamma function," by G. D. Birkhoff; "Some properties of space curves minimizing a definite integral with discontinuous integrand," by E. J. Miles; "The degree of a cartesian multiplier," by D. R. Curtiss; "On closed continuous curves," by Arnold Emch; "Let us have our calculus early" (review of Mercer's "Calculus for Beginners"), by E. B. Wilson; "Shorter Notice": Ziwet and Field's "Introduction to Analytical Mechanics," by Kurt Laves; "Notes"; and "New Publications."

THE November number of the *Bulletin* contains: Report of the twentieth summer meeting of the society, by H. E. Slaught; "Intuitionism and formalism," by L. E. J. Brouwer; "Shorter Notices": Arnoux's "Essai de Géométrie analytique modulaire à deux Dimensions," by L. E. Dickson; Padoa's "La Logique déductive dans sa dernière Phase de Développement," by J. B. Shaw; Hun and MacInnes's "Elements of Plane and Spherical Trigonometry," by Cora B. Hennel; "Notes"; and "New Publications."

THE articles in *The American Journal of Science* for November are as follows:

"Upper Devonian Delta of the Appalachian Geosyncline," by J. Barrell.

"Optical Bench for Elementary Work," by H. W. Farwell.

"Volcanic Research at Kilauea in the Summer of 1911," by F. A. Perret; with Report by A. Brun.

"Observations on the Stem Structure of *Psaronius Brasiliensis*," by O. A. Derby.

"Fauna of the Florissant (Colorado) Shales," by T. D. A. Cockerell.

"The Photoelectric Effect," by L. Page.

"Graphical Methods in Microscopical Petrography," by F. E. Wright. (With Plates II. to IX.)

"A Graphical Plot for Use in the Microscopical Determination of the Plagioclase Feldspars," by F. E. Wright.

"On the Influence of Alcohol and of Cane Sugar upon the Rate of Solution of Cadmium in Dissolved Iodine," by R. G. Van Name and D. U. Hill.

"Comparative Studies of Magnetic Phenomena. IV. Twist in Steel and Nickel Rods due to a Longitudinal Magnetic Field," by S. R. Williams.

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## *A NOTE ON PENFOLD'S MODIFICATION OF BACILLUS COLI COMMUNIS*[1]

PENFOLD'S[2] observation, that the cultivation of *Bacillus coli communis* upon monochloracetic acid media permits the selection of strains whose power to produce gas from certain sugars is permanently lost, has an important bearing not only upon mutation, but upon the mechanism of the carbohydrate metabolism of coliform organisms.

Through the work of Scruel,[3] Frankland and Frew,[4] Pakes and Jollyman,[5] Harden[6] and others, there has been gathered considerable evidence that the hydrogen and carbon dioxide, liberated in the fermentation of various sugars and allied compounds by coliform organisms, are the products of the decomposition of formic acid in accordance with the equation:

$$H_2CO_2 = H_2 + CO_2.$$

This decomposition has been attributed to the activity of a specific enzyme for which

[1] From the U. S. Department of Agriculture, Bureau of Animal Industry, Dairy Division.

[2] Penfold, W. J., *Proceedings of the Royal Society of Medicine*, Pathological Section, Vol. 4, Part 3, p. 97, 1910–11; *Journal of Hygiene*, Vol. II., p. 487, 1911.

[3] Scruel, *Arch. med. Belges*, ser. 3, t. 42, p. 362, 1892; ser. 4, t. 1, pp. 9 and 83, 1893.

[4] Frankland, Percy F., and Frew, William, *Journal of Chemical Society Transactions*, Vol. 61, p. 254, 1892, London.

[5] Pakes, Walter Charles Cross, and Jollyman, Walter Henry, *Journal of Chemical Society Transactions*, Vol. 79, Part 1, p. 386, 1901, London.

[6] Harden, Arthur, *Journal Chemical Society Transactions*, Vol. 79, Part 1, p. 610, 1901, London.

Franzen and Stuppuhn[7] have proposed the name formiase.

The important point in Harden's comparison of the products of fermentation of *Bacillus coli* and *Bacillus typhosus* lies in the fact that the products are very similar, with the exception that *typhosus* leaves considerable formic acid and no gas, while *coli* leaves little formic acid and produces considerable hydrogen and carbon dioxid. This suggests that an essential characteristic of *coli* and of similar gas-producing bacteria is their ability to elaborate the enzyme formiase. This enzyme was supposed to be active both in the gaseous fermentation of sugars and of the related alcohols.

Penfold's observation that by artificial selection a strain of *coli* may be isolated which retains its power to produce gas from certain alcohols while it has lost this power in its attack upon sugars, has therefore a profound theoretical significance.

In addition to this Penfold seems to have arrived at the conclusion that, if strains without the power to produce gas from sugars may be selected by artificial means, there is no certainty that they may not arise either in nature, or during ordinary laboratory cultivation, and so lessen the reliance which is to be placed upon the gas test in diagnosis. Indeed, if Penfold's conclusions are strictly interpreted, we are no longer able to attribute to an organism of the colon group, any characteristic which may be called a fundamental and immutable physiological function.

If the theory of natural selection in any of its original or modern forms is held applicable to bacteria, we must perhaps admit the probability that bacteria are subject to variation. That they do vary we will not dispute. That they may be made to undergo mutations, or that conditions may be imposed upon their growth in such a way that selection takes place in certain directions, we will not debate. We do insist, however, that before it is concluded that such mutations or selections have occurred in any specific instance, the analytical methods used to demonstrate these phenomena be methods of sufficient accuracy to establish confidence in the data.

While Penfold's conclusions may be in the main correct, there appear certain inaccuracies in his methods which detract from the confidence such important deductions should carry with them. We wish to call attention to these inaccuracies not so much as a polemic against Penfold, as a plea for greater care in the analytical procedures of bacteriological chemistry.

Penfold in his tests of gas production used the Durham tube. The Durham tube, while useful as a preliminary qualitative test for gas, is otherwise worthless. It is more inaccurate than the Smith tube, whose shortcomings were not only recognized by the originator, but more fully pointed out by Keyes.[8]

The gravest fault of each is the retention of a large proportion of $CO_2$ by the medium. Keyes's method of cultivating colon in vacuo, and pumping out the gas for careful analysis over mercury, seemed so promising that it was employed with certain modifications by Rogers, Clark and Davis[9] in their study of the gases produced by over 200 cultures of bacteria, among which those which we are justified in calling typical colons were abundant.

A remarkable constancy both in total amount of gas and in the ratio of the constituent gases produced by colon was demonstrated. Incident to this research, the gas production of a typical colon when grown on various media was studied. It was found that while the total amount of gas obtained after 7 days' incubation from 5 c.c. of a broth containing ½ per cent. $K_2HPO_4$ and 1 per cent. of sugar, was quite uniformly about 8 c.c., whether the sugar was dextrose or galactose, the total amount of gas obtainable from the same medium rose to 12 c.c. when dulcite or mannite was substituted for a hexose.

If we compare these results with the graphic representation of Penfold's determinations, on page 489 of his second article, we shall find

[7] Franzen and Stuppuhn, *Zt. f. Physiol. Chem.*, Vol. 77, p. 129, 1912.

[8] Keyes, *Journal of Medical Research*, Vol. 21, No. 1, p. 69, 1909.

[9] Rogers, L. A., Clark, Wm. Mansfield, and Davis, Brooke, paper about to be published.

some suggestive comparisons. In each set of results, the total gas produced by a *normal* colon from dextrose equals that from galactose, and the total gas from dulcite equals that from mannite. In each set, the total gas from dulcite and mannite exceeds that from galactose and dextrose. In our results, the total gas from the alcohols is one and one half times that from the sugars.

We have also found that the total gas produced by colon in a peptone water medium, such as Penfold used, is but little more than half that produced in our broth with phosphate.

With these facts in mind let us assume that we have to cultivate in peptone water a colon whose physiological powers are identical with those of a normal organism except that its activity has been greatly weakened. If it produces only enough gas from dextrose or galactose to saturate the medium, none will appear in a Durham tube, and it *might* be said that the gas-producing power was *nil.* If the same relative power to ferment alcohols that a normal organism possesses, is still preserved, the weakened organism might show some gas in a Durham tube in dulcite or mannite medium.

When grown in Durham tubes, Penfold's selected strain showed no gas in dextrose or galactose media, while it did in mannite and dulcite media. Our results show that a normal colon produces much more gas from these alcohols, and it may therefore be suspected that Penfold's strain shows gas from these alcohols and not from the sugars simply because it produces from the alcohols a sufficiently greater volume of gas to become manifest.

It is significant that Harden and Penfold[10] by applying the more exact method of Harden,[11] found that the selected organism instead of producing no gas from dextrose, as Penfold found by the Durham tube method, *does* produce both hydrogen and carbon dioxid. The ratio of these gases was not accurately determined, but the amount of hydrogen was found to be only 15 per cent. of that obtained from a normal colon. The other products, with the exception of lactic acid, were also greatly reduced.

Consequently, instead of concluding, as Penfold did, that his selected organism has had its power to produce gas from dextrose destroyed, and that its physiological characteristics have been qualitatively altered, we may just as reasonably conclude, so far as Penfold's original data are concerned, that the selected organism has merely been weakened. In addition to this it should be noted that Penfold has had difficulty in producing with *B. lactis aerogenes* modification similar to that obtained with *B. coli communis.* In view of this fact it may be illuminating to recall that Harden and Walpole[12] found that *B. lactis aerogenes* furnishes much more gas than does *B. coli* on the same medium.

If Penfold's culture is in this essential identical with that of Harden and Walpole, or with one of those organisms which Rogers, Clark and Davis have described as producing both more gas and a higher gas ratio than *B. coli,* then it may be that Penfold could not "suppress" the evolution of gas from his *lactis aerogenes* cultures, simply because he could not *weaken* it enough to prevent the formation of sufficient gas to more than saturate the medium; and not because it refused to undergo that fundamental "variation" which Penfold ascribes to *coli.*

It is of course impossible to make any accurate comparisons between our own exact determinations and those of Penfold, for the purpose of estimating the extent of his error. The unreliability and general inconstancy of gas determinations made with the Durham or Smith tubes is, or should be, universally recognized. Of special significance is the more recent work of Keyes and Gillespie[13] in demonstrating that in contrast to anaerobic growths there is a marked variation in the gas ratio of

[10] Harden, Arthur, and Penford, W. J., *Proceedings Royal Society,* B. 85, p. 415, 1912.

[11] Harden, Arthur, *London Journ. Chem. Soc.,* 1901, p. 610.

[12] Harden, Arthur, and Walpole, *Proceedings Royal Society,* B. 77, p. 399, 1906.

[13] Keyes and Gillepsie, *Journal Biological Chemistry,* Vol. 13, No. 3, p. 305, 1912.

aerobic cultures of *Bacillus coli*. This throws additional doubt upon the reliability of gas determinations made by the methods in common use.

Based largely upon his results with the Durham tube, Penfold at one time or another has come to the following conclusions:

> It may be suggested, therefore, that . . . the selective process has caused the removal of the formic-acid-forming ferment, but apparently has not interfered with the formic-acid splitting ferment.[14]
>
> The power of gas formation from sugars (always excepting isodulcite) may be lost when gas formation from alcohols is retained. It is probable, therefore, that two different ferments are engaged in the respective processes.[15]
>
> The research raises the question as to the weight to be attached to the power of fermenting glucose and lactose with gas formation in recognizing *B. coli* in routine examinations of pathological material, water, foods, etc. Hitherto, in all authoritative catalogues of the necessary properties of this organism, this has been included, but it probably ought not to be regarded as absolutely essential.[16]

Perhaps more exact work will demonstrate the essential truths there may be in these statements. If so, it will in no wise alter the contention of this article, which is that conclusions of such profound importance are worthy of being established by methods of reasonable accuracy.

It is gratifying to learn that Harden and Penfold have set out to do so. Pending the fuller publication of their results this article would not have been written but for the fact that Penfold since the publication of the preliminary report of Harden and Penfold, has published another paper,[17] in which he seems to have missed the *significance* of the discrepancy between his earlier statement that the variant colon produces no gas from dextrose, and Harden and Penfold's later statement that it does.

[14] Penfold, W. T., *Proceedings Royal Society of Medicine*, Pathological Section, Vol. 4, Part 3, p. 106.

[15] Penfold, W. T., *Journal of Hygiene*, Vol. II., p. 502.

[16] Penfold, W. T., *ibid.*

[17] *Journal of Hygiene*, April, 1913.

Unfortunately Penfold is not alone in the false confidence he has placed in the reliability of the Smith and Durham tube methods of bacterial gas determination. These instruments, which are useful only in the routine laboratory, are still being widely used in elaborate researches; and the time, therefore, seems ripe to emphasize the errors to which their use may lead, and to plead for greater accuracy in this important test of bacteriological chemistry.

Wm. Mansfield Clark
Washington, D. C.

## *SPECIAL ARTICLES*

### A NEW MEANS OF TRANSMITTING THE FOWL NEMATODE, HETERAKIS PERSPICILLUM

It has been found that *Heterakis perspicillum* may be transmitted to young chicks by a dung earthworm found in horse manure. The earthworm in question is probably *Helodrilus parvus* (Eisen).[1] The experiment demonstrating this relationship was performed during the past summer at the Kansas State Agricultural College. Eleven chicks, as soon as hatched, were placed in a fly-proof field cage and kept there until the close of the experiment. The cage was so constructed that the chicks could not reach chance insects that happened to light upon the outside screen. It had two fly-proof doors enclosing an entry way and the outer door was kept locked. When entering the cage the outer door was closed and the entry inspected for chance flies before opening the inner door. On leaving the pen the same care was taken. All chicks were thrifty and were fed upon the same ration of dry food to which was added twice per day some green alfalfa. It is needless to say that the alfalfa was always examined to prevent any insects from entering the pen. The earthworms were fed to three of the chicks. To the first chick a total of 78 worms was fed in lots of six to twelve each day between July 17 and July 26, inclusive. To the second chick 64 were fed, July 18 to July 29. The

[1] The earthworm mentioned has been referred to Professor Frank Smith, University of Illinois, for identification, and the nematode has been verified by Dr. Albert Hassell, Division of Zoology, B.A.I., Washington, D. C.

third chick received 53 worms between July 19 and July 28. When these chicks were killed September 5, twenty adult *Heterakis* were found in the first, six in the second and two in the third. Eight other chicks, from the same cage and killed at the same time, which had been kept under identical conditions, except that no earthworms were fed to them, did not show a single *Heterakis* present. There appears to be no escape from the conclusion that *Helodrilus* in some way may serve as an intermediate host for this nematode. The experiment does not show the nature of the transmission. Whether it is a case of true parasitism or is simply an association remains to be proved. It may be that the eggs of *Heterakis* simply cling to the more or less slimy surface of the earthworm and are transmitted in this way. Favoring this view is the probability that young chicks can become infected through eating eggs scattered in the feces of older chickens. However, the fact that small nematodes are frequently found in the nephridia of certain earthworms might furnish another suggestive hypothesis. Whatever the exact nature of transmission, the results are interesting. A hen and four young fowls, taken at random from the barnyard where the earthworms were found, were killed and examined for *Heterakis*. Nematodes were present in only two of these. Some of the fowls had the habit of going to the field instead of scratching and wallowing around the manure heap and this perhaps explains why more were not infected. Then the chances are small that any one chick would obtain a large number of earthworms, though the latter were only a short distance below the surface. In any case feeding *Helodrilus* under the conditions described was an efficient means of transmitting the *Heterakis* to young chicks.

JOHN W. SCOTT
UNIVERSITY OF WYOMING,
September 25, 1913

## A NEW SPECIES OF MOROPUS (M. HOLLANDI) FROM THE BASE OF THE MIDDLE MIOCENE OF WESTERN NEBRASKA

WHILE studying the material representing the Chalicotheres in the Carnegie Museum in connection with the revision of the superfamily Chalicotheroidea, which is about to be published, the writer has found that a quantity of material representing a specimen from the Upper Harrison Beds of western Nebraska (Middle Miocene) is undoubtedly referable to a new species, which he desires to name in honor of Dr. W. J. Holland, the Director of the Carnegie Museum.

*Moropus Hollandi* sp. nov.

*Type Specimen.*—Radius, ulna, and portion of fore foot, femur, tibia, fragment of fibula, and portions of both hind feet. No. 1424, Carnegie Museum Collection. This material was discovered in 1901 and partially described by O. A. Peterson (*Ann. Car. Mus.*, Vol. IV., pp. 60–61, 1906) as *M. elatus*.

*Specific Characters.*—Limbs slenderer than in *M. elatus* Marsh or *M. petersoni* Holland. Third trochanter of femur somewhat less developed than in the latter species; facet for the trapezium on the scaphoid much reduced, or wanting; facet for trapezium on *Mc. II* wanting; metacarpals proportionally long and slender; proximal and median phalanges of second digit of manus more compressed laterally than in *M. elatus* or *M. petersoni*. The animal was larger than a tapir, but considerably smaller than *M. elatus* Marsh, which was as large as a rhinoceros.

A more detailed description of this species will appear in the work to which reference has been made, the first part of which has gone to the printer.

O. A. PETERSON
CARNEGIE MUSEUM,
October 8, 1913.

## THE AMERICAN CHEMICAL SOCIETY

ROCHESTER MEETING

II

BIOLOGICAL CHEMISTRY SECTION

Carl L. Alsberg, *Chairman*
I. K. Phelps, *Secretary*

T. B. ALDRICH: *On the Presence of Histidine-like Bodies in the Pituitary Gland (Posterior Lobe).* (Preliminary communication.)

From the Research Laboratory of Parke, Davis & Co., Detroit, Mich. Employing Pauly's diazo-

benzene sulphonic acid reaction for the detection of histidine it seems probable that histidine or some form of it in a free state is contained in the desiccated posterior lobe of the pituitary gland, since by benzoylating direct, using Inouye's method Pauly's reaction was positive and that the body (or bodies) giving Pauly's reaction after hydrolysis by means of mineral acids or digesting with pancreatin is not tyrosine (which gives a similar reaction) since after benzoylating the histidine reaction still persists. Furthermore, the histidine-like body (or bodies) is probably not histidine, since it does not give Weidel's reaction as modified by Fischer or Knopp's reaction with bromine.

It would seem probable also that Pauly's reaction is not a specific reaction for histidine, but a reaction for certain bodies yet to be positively determined.

J. H. Long: *The Mutual Action of Pepsin and Trypsin.*

The older physiologists seem to have considered this a comparatively simple question, but their findings were not in agreement. Kühne was one of the first to discuss the problem and he concluded that pepsin destroys trypsin. This is probably correct, but his experimental evidence does not warrant the statement. In all such experiments the reaction of the medium must be pretty definitely known, as the content of hydrogen or hydroxyl ions is often the determining factor. In most of the older work these points were almost wholly overlooked, as the combining power of protein for acid or alkali was not known or not recognized. Making a due allowance for the reaction of the medium, the present experiments show that within the practical limits of body behavior trypsin has no important action on pepsin, while the action of pepsin on trypsin is markedly destructive, while an acid medium weakens the trypsin, pepsin plus acid seems to destroy it rather rapidly.

G. O. Higley: *A Further Study on the Well Water of Delaware, Ohio.*

The purpose of this study was to supplement that reported on at the spring meeting—to trace the relation between well water and an outbreak of typhoid. The city water had been examined and found safe. The water of about 100 wells has been analyzed and much of it found polluted. Five vaults were now selected in various parts of the city and in widely different soils: these were heavily salted and a weekly test for chlorides made during a period of nearly two months of the water of thirteen wells located from 58 to 118 feet from the vaults. Comparison of results of analyses made before and after the salting process, showed a decided increase in chlorides in well water at four of the five centers and in seven of the thirteen wells.

H. P. Armsby: *Comparison of the Observed and Computed Heat Production of Cattle.*

Jacob Rosenbloom and S. Roy Mills: *The Non-interference of Ptomaines with Certain Tests for Morphine.*

We have determined experimentally that bacterial products formed during aerobic and anaerobic putrefaction of various human organs do not give reactions simulating those due to the presence of morphine and in no way do they interfere with the detection of morphine when added to these putrefactive products.

Jacob Rosenbloom: *On the Distribution of Mercury Following Acute Bichloride of Mercury Poisoning.*

The writer has estimated the amount of mercury in the organs of a woman who died eight days after ingestion of bichloride of mercury.

James P. Atkinson: *The Effect of Electrolysis on Whole Proteins, Witte's Peptone, and some of their Decomposition Products.*

Whole protein (egg white), Witte's peptone and protein (horse serum), hydrolyzed by hydrochloric acid, yield approximately 50 per cent. of the total nitrogen as ammonia when electrolyzed in a sulphuric-acid solution. The amino acids tested, glycylglycine, uric acid and urea, do not yield as much nitrogen as ammonia under the same conditions, while ammonium sulphate is unaffected.

A. F. Blakeslee and R. A. Gortner: *The Non-development of Cytolytic Sera following the Intravenous Injection of Mould Spores.*

Intravenous injections of the spores of each race of Mucor "V" were given to rabbits, rabbit No. 5 receiving 30 injections of the ♂ race and rabbit No. 55 receiving 29 injections of the ♀ race. Each injection would average about 500,000,000 spores. Following the last injection of approximately 800,000,000 spores a loop of blood was taken at intervals of 30 minutes for 6 hours, then every hour for 4 hours more, then every two hours for 16 hours more and later at less frequent intervals. Separation cultures were made of agar which contained the loop of blood taken and the number of mould colonies which developed were counted. A similar test was made at the same time, using rabbits which had received their first injection of the spores. In each case the disappearance of the

spores occurred after about 43 hours, the immunized rabbits retaining the viable spores as long as the check rabbits.

R. A. GORTNER and A. F. BLAKESLEE: *The Occurrence of a Toxin in the Bread Mould, Rhizopus nigricans.*

We have found that there is a toxin in the bread mould which, when administered intravenously to rabbits, causes their death with all of the symptoms of anaphylaxis. The toxin is stable to peptic digestion and to heating at 100° for five minutes. The toxin, as prepared, is present in the mould to about 4 per cent., is soluble in water, from which solution it may be precipitated by alcohol, and is non-dialyzable. The lethal dose for rabbits, when given intravenously, is about 1:225,000 parts of body weight.

RAY E. NEIDIG: *Effect of Acids Upon the Catalase of Taka-diastase.*

Data were presented showing the inhibiting effect of several of the important inorganic and organic acids toward catalase of taka-diastase. Curves were plotted for different acid concentrations which show the quantity of oxygen liberated at stated intervals. The acids, arranged in order of the magnitude of their inhibiting effect for equinormal solutions, are as follows: sulphuric, hydrochloric, oxalic, tartaric, citric and acetic. The inhibiting effect of the first three was much more pronounced than that of the others. Neutralization of the acid solution usually restored some of the activity, the amount of increase depending upon the particular acid used. Van Slyke's amino-nitrogen apparatus was used in these experiments for measuring the amount of oxygen liberated.

RAY E. NEIDIG: *Polyatomic Alcohols as Sources of Carbon for Molds.*

A comparison of some of the polyatomic alcohols occurring in nature was undertaken in order to determine the degree of their utilization by molds as sole sources of carbon. The alcohols used were methyl alcohol, glycol, glycerol, erythrite, adonite, mannite, dulcite and sorbite. Eight species of molds representing four genera were cultivated in media containing these alcohols.

It was found that methyl alcohol produced no growth, glycol induced germination only, glycerol produced strong cultures, erythrite could be used by the majority of molds and adonite by only a few, while all three of the hexatomic alcohols may be regarded as good sources of carbon. These results indicate that molds are able to use both optically active and inactive compounds as sources of carbon. If viewed from the standpoint of their oxidation products it is possible that active compounds are first formed and these are then utilized in the development of the molds.

ARTHUR W. DOX and W. E. RUTH: *Cleavage of Benzoylalanine by Mold Enzymes.*

Continuing our studies on the enzymic cleavage of glycocoll derivatives by means of the formol-titrimetric method, a homologue of hippuric acid, viz., benzoylalanine, was tested. Seven species of the lower fungi were found to produce an enzyme capable of decomposing *dl*-benzoylalanine to the extent of 12.8 per cent. to 24.5 per cent. in two weeks.

F. C. COOK: *The Importance of Food Accessories as shown by Rat-feeding Experiments.*

Most of the twelve white rats fed on a basal diet of protein, fat, carbohydrates and salts for eighty days lost weight during the last three weeks. For thirty-five days immediately following, 5 c.c. of meat extract, plant extract solution or milk were alternately added to the basal diet, the nitrogen and sodium chloride being equal. Milk and meat extract stimulated growth, plant extract showed little stimulating power. Eleven young white rats fed for thirty-five days on the basal diet, plus one of the three accessories, showed similar results. Milk, also meat extract, gave the biuret reaction and precipitates with phosphotungstic acid. Plant extract gave neither. Meat extract is a hydrolyzed product practically free from fat and carbohydrates. The rats gained more on a smaller number of calories when milk or meat extract was ingested than when fed on the basal diet alone.

CHRISTINE CHAPMAN and W. C. ETHERIDGE: *Influence of Certain Organic Substances Upon the Secretion of Diastase by Various Fungi.*

In this work the influence of varying concentration of cane sugar, glucose, peptone and tannic acid upon the secretion of diastase by *Aspergillus niger, Aspergillus Oryzæ, Penicillium expansum, Penicillium camembertii, Mucor Rouxii* and *Cephalothecium roseum* has been investigated. Czapek's solution was employed with the sugar replaced by 0.4 per cent. soluble starch. To this was added the quantity substance whose influence was to be determined. It was found in general that the presence of any of the above organic substances retarded the secretion of diastase by the fungi mentioned. The higher the concentration the greater the retardation.

H. H. BUNZEL: *The Rôle of Oxidases in the Curly Dwarf Disease of Potatoes.*

Oliver E. Closson: *A Time Recorder for Kymograph Tracings.*

It is at best a tedious operation to find the projection of the time record on the different graphs as ordinarily traced upon smoked paper.

By the following simple device the time interval can easily be recorded by a fine line, entirely across the paper.

A fine spring wire stretched two to three millimeters from the smoked surface will, when picked by the armature of the time signal magnet, strike the smoked paper on the rebound and remove a fine line of soot.

By a little adjusting a single distinct line is recorded at each closure of the circuit. If it is inconvenient to adjust any recorder to write perpendicular to the base line it is a simple matter to adjust so that the time line is parallel to any such line.

Oliver E. Closson: *Apparatus for Studying Oxidases.*

The reaction of oxidases with hydrogen peroxide liberates heat, and the temperature factor being large as well as the expansion of the gas, all necessitate a thermostat control and continued agitation of the mixture for comparative studies.

To obtain uniform temperature and continuous record of the liberated gas the following apparatus was devised.

A shaking member with two compartments, one for holding the hydrogen peroxide and the other for the enzyme solution, is connected by a tube with ground joint to a large cylindrical container with center at the axis of motion so that liquid in this container is not agitated by motion around the axis. This arrangement allows the shaking of the reacting solution and the measure of the liberated oxygen by the water displaced.

The large container has a tube extending along the axis to the outside of the thermostat, which allows the discharge of the displaced water into a vessel suspended by a spring, so that a writing arm can be made to record the volume, giving on a rotating drum a curve, which can be analyzed at one's leisure.

Amos W. Peters and Mary E. Turnbull: *A Method for Studying Slight Degrees of Glycosuria, Adapted from Macleod and S. R. Benedict.*

Urine is clarified by the method of Macleod, *i. e.*, urine + concentrated acetic acid + Merck's blood charcoal. No sugar is lost by this procedure, the urine is diluted to only 7/5 original volume, the filtrate is water-clear for polarization. Five c.c. of the filtrate, contained in a 100 c.c. Kjeldahl flask, is neutralized with saturated solution of $Na_2CO_3$, using alizarine, and 5 c.c. of a modified Benedict reagent is added. After placing a pebble in the liquid and fixing the flask in an inclined position directly over a small Bunsen flame the whole is boiled for 2½ minutes. The resulting small volume is transferred to a centrifuge tube and made to 10 c.c. Examined under a shaded electric light and against a dark background even a trace of dextrose shows turbidity, and after centrifugation so little as 0.0035 per cent. shows a film of red precipitate. Quantitative estimations are made by comparison with standards based upon a normal urine obtained under normal diet and showing zero rotation, or nearly so, after clarification, and to which dextrose is added in steps of 0.01 per cent. The sensitivity is such that pronounced differences result with these small intervals.

Composition of the above reagent: Sod. citrate 100 gm.; sod. acetate 100 gm.; sod. carb. anhyd. 50 gm.; cryst. copper sulph. (Kahlbaum) 12.5 gm.; dist. water add 500 c.c.

W. S. Hubbard and D. M. Cowie: *A Method of Estimating Fat in Infant Stools.*

S. L. Jodidi: *Nature of Humus and its Relation to Plant Life.*

Philip Adolph Kober: *The Estimation of Protein, Animo and Nucleic Acids in Potable Waters.*

William N. Berg: *Surface Tension in Muscle Contraction.*

Macallum quotes Jensen to the effect that "a thread measuring 1 millimeter in diameter formed of the plasmodium of *Chondrioderma*, a Myxomycete, may, when it is in the dense condition, bear up a weight of nearly a gram. If the force engaged is surface tension it would amount to about 6,000 dynes per centimeter."

At the same time Macallum does not quote Pfeffer, who says that in the case of the plasmodium of *Chondrioderma*, the outer membrane may vary reversibly, in its consistency, from that of the fluid protoplasm in the interior of the cell to that of solid gelatinous masses.

Jensen obtained the figure of 6,000 dynes per centimeter by dividing the weight sustained by the plasmodium thread by the circumference of the thread. It would have been just as logical to divide the weight sustained by a steel wire by the circumference of the wire and call the equipment the surface tension of steel.

C. S. HUDSON and T. S. HARDING: *The Estimation of Raffinose by a Modified Biological Method.*

WILLIAM SALANT and J. B. RIEGER: *The Elimination of Zinc.*

The experiments were made on rabbits. Zinc was given intravenously and zinc acetate subcutaneously. The urine collected for period of 24–48 hours showed the presence of 1–2 milligrams of zinc. Much larger amounts were found in the feces and contents of the gastro-intestinal canal after the subcutaneous injections. The quantities of zinc varied between 8.5 and 17.1 milligrams in 24–48 hours, which represented 10–34 per cent. of the amounts introduced. The amounts of zinc eliminated by this channel were greater after intravenous injection, being 17–20 milligrams, or 40 per cent. of the quantity administered.

WILLIAM SALANT and L. P. TREUTHARDT: *The Absorption and Fate of Tin in the Body.*

Tin in the form of a double salt was given subcutaneously and by mouth to different animals. Analyses of the urine and feces, contents of the stomach and intestines, which were made gravimetrically and volumetrically, gave the following results: After the subcutaneous administration 5–15 per cent. was eliminated in the urine in 24–48 hours. The feces of the corresponding period contained much smaller amounts. The contents of the stomach and intestines and the feces contained as much or more tin than the urine. In some animals the amount of tin eliminated by the kidneys was smaller than that recovered from the gastro-intestinal contents and feces.

Analysis of the skin indicated the presence of 20–25 per cent. of the amount of tin injected.

When double salts of tin were given by mouth, small quantities of it were found in the tissues and in the urine, indicating that absorption from the gastrointestinal canal takes place to a very small extent only and may be insignificant in some animals.

The amount of tin found in the liver of rabbits at the end of 48 hours varied between 0.6 per cent. and 10.8 per cent. The kidneys of such animals contained quantities varying between 1.6 and 8.2 per cent. of the amount of tin injected. Experiments on the absorption of salt from the blood indicate that 85–95 per cent. may disappear in 2–3 hours after the intravenous injection of 70–200 milligrams tin.

DONALD D. VAN SLYKE and GUSTAVE M. MEYER: *The Fate of Protein Digestion Products in the Body.*

Previous work by the authors has shown that during digestion amino acids are absorbed into the blood, as the amino acid nitrogen of the latter per 100 c.c. rises, in a dog, from 4–5 mg. before feeding to 10–12 mg. after a meal of meat. The low concentration of amino acids in the blood even at its maximum indicates that the digestive products must be removed rapidly from the circulation. This is found to be the case after the injection of amino acids directly into the circulation. They disappear from the blood almost as fast as they enter it. Analysis of the tissue shows that these have absorbed the amino acids from the blood, without subjecting them to any immediate chemical change. This apparently follows later, but in the muscles is so slow that no decrease in amino acid nitrogen can be determined within the first 3–4 hours after the injection. In the liver, on the other hand, the amino acids absorbed as the result of the injection have entirely disappeared in this time, indicating that the metabolism of these products is particularly rapid in the liver. It is less so in the other organs, but whether as sluggish as in the muscles is not yet certain. During starvation the amino nitrogen of the tissues, which amounts to 40–80 mg. per 100 gm. of fresh tissue, tends to increase rather than disappear, indicating that the amino acids of the tissues can originate from autolysis of the tissues themselves as well as from digestion of food proteins.

GEORGE PEIRCE: *The Configuration of Some Heptoses.*

*d*-*a*-mannohexahydroxyheptoric acid and *d*-*a*-galahexahydroxyheptoric acid yield on oxidation two pentahydroxykinetic acids that are optical antipodes of each other. The configuration of four of the asymmetric carbon atoms in each monobasic acid is known and the configuration of the fifth is given by the above fact. The corresponding heptites are also optical antipodes.

| | | | |
|---|---|---|---|
| $CO_2H$ | $CO_2H$ | $CO_2H$ | $CO_2H$ |
| HCOH | HOCH | HOCH | HCOH |
| HOCH | HOCH | HOCH | HOCH |
| HOCH | HOCH | HCOH | HCOH |
| HCOH | HCOH | HCOH | HCOH |
| HCOH | HCOH | HOCH | HOCH |
| $CH_2OH$ | $CH_2OH$ | $CH_2OH$ | $CH_2OH$ |
| I. | II. | III. | IV. |
| From *d*-mannose. | | From *d*-galactose. | |

Of the following four configurations I. and III. are seen to be the two that give optical antipodes on oxidation or reduction of the end carbon atoms. These two are, therefore, the formulæ for the $\alpha$ compounds. The $\beta$ galactose compounds of

formula IV. have been synthetized. The β mannose compounds of formula II. have not yet been prepared.

M. X. Sullivan: *Some Organic Constituents of the Culture Solution and the Mycelium of Molds from Soil.*

Examination was made of the dried mycelium of mixed mold cultures from soil and of *Penicillium glaucum* grown on Raulin's solution and of the filtered solution after mold growth for organic constituents. In the mixed molds was found a large number of organic substances, many of which were subsequently found in *Penicillium glaucum*. In the alcoholic soda extract of *Penicillium glaucum* were found oleic and palmitic acids, a fatty acid melting at 54° C., a fatty acid which appears to be elaidic acid, hypoxanthine, guanine and adenine, histidine, thymine and chlorine. In the direct alcohol extract was found mannite, cholesterol bodies, hypoxanthine and cerebrosides. From mold grown on Raulin's solution plus peptone a small amount of guanidine was found. In the culture solution after a number of weeks' growth were found fatty acids, purine bases, a small quantity of a histidine-like body, pentose sugar, unidentified aldehydes, etc. Many of these compounds have been found in soil and the conclusion is drawn that microorganisms, such as yeasts, bacteria and molds, play an important part in their formation.

M. X. Sullivan: *Vanillin in Wheat and its Relation to Soil.*

By means of the sodium bisulphite aldehyde method, an aldehyde smelling like vanillin and giving vanillin color reactions was found in the alcohol and ether extracts of ungerminated wheat seeds, in the roots, seeds and tops, respectively, of young wheat seedlings in rotten wood, and in the water in which wheat had germinated and grown. Estimated quantitatively by Folin and Denis's colorimetric method, the amount in the ungerminated seed is small, several parts per million, but is considerably increased during germination and the early stages of growth. Treating the seed with 5 per cent. sulphuric acid also increased the amount of vanillin extractable. The presence of vanillin in other plants was indicated. The vanillin of soil undoubtedly has its origin in part in vegetable débris and plant.

W. R. Bloor: *A Method for the Determination of Small Amounts of Fat.* (Preliminary report.)

The method consists essentially in extracting the fat from the tissue or liquid with an excess of alcohol-ether (25 per cent. ether), measuring an aliquot portion of the filtered extract into distilled water and determining the amount of fat by comparison of the cloudy suspension so obtained with a standard fat solution by the use of the nephelometer. The method has given good results with blood and milk.

C. G. MacArthur and G. Norbury: *Nitrogenous Hydrolysis Products of Several Phosphatids.*

Sheep brain kephalin, sheep brain lecithin, ox heart cuorin and ox heart lecithin were prepared, purified and then hydrolyzed in a dilute hydrochloric acid solution. In each case the fatty acid residue contained nitrogen, usually about one sixth of the total. The filtrate nitrogen was separated by a special method into four fractions, representing (1) ammonia, (2) chlorine or other basic compound, (3) amino acid, or compounds not precipitated by platinum chloride but precipitated by mercuric acetate in a sodium carbonate solution, and (4) the filtrate from (3). The two lecithins contain about two fifths of the nitrogen in the form (2), while kephalin and cuorin contain practically none. In all of them, fraction (3) is large, varying from one third to one half.

L. V. Burton and C. G. MacArthur: *Fatty Acids from Kephalin.*

The fatty acids obtained from hydrolyzing purified kephalin in a dilute hydrochloric acid solution were separated by the lead acetate method into the saturated and unsaturated fatty acids. The saturated acid fraction represented about one third of the total and was found to contain stearic and palmitic in the ratio of three to one. The unsaturated fatty acids were separated by the bromination method into clupanodenic acid, linolic acid and oleic acid. The amount of clupanodenic acid present was small, less than 2 per cent. The linolic acid was found to represent about one sixth of the total fatty acids. Oleic acid comprised about one third of the total.

E. B. Forbes: *A Metabolism Experiment with Swine.*

The usual practical rations for swine contain an excess of acid over basic mineral elements. Urinary ammonia varies directly with this excess of mineral acid, provided the protein intake remains the same. Increased protein intake increases urinary ammonia. This excess of mineral acid in practical swine rations seems not to affect calcium retention.

Water-drinking caused the elimination of sodium and chlorine; abstinence from drinking leads

to their retention. The feces may contain an abundance of sodium, but are nearly free from chlorine.

Potassium, magnesium and chlorine balances were usually positive, but were negative during periods of maximum intake, apparently through over-response in the way of protective elimination of excess ingested.

Calcium retention was satisfactory only on rations containing meat meal containing considerable bone and skim milk. Neither cereals nor soy beans furnish the calcium requisite for growth.

An excess of magnesium to calcium caused loss of calcium with a ration of rice polish and wheat bran. The excess of magnesium to calcium in corn and in other practical rations does not appreciably restrict calcium retention.

The important deficiencies of corn are, in order of magnitude, first, calcium; second, phosphorus; third, nitrogen.

Creatinin elimination was entirely independent of food, but varied in the same order as live weight, weight of dressed carcass, of flesh, of bones and of blood.

Soy beans, meat meal and skim milk increase the digestibility of the carbohydrates of the corn with which they are fed. Meat meal and skim milk increase the apparent digestibility of the fat, and decrease the digestibility of the crude fiber of the corn with which they are fed, the results being digestion coefficients of more than 100 and less than nothing.

V. C. MYERS and M. S. FINE: *The Fate of Creatine and Creatinine when Administered to Rabbits.*

When creatine is administered subcutaneously to rabbits in amounts varying between 50 and 100 mgm. per kgm. of body weight per day, 25–80 per cent., depending upon the amount given, reappears in the urine unchanged, 2–10 per cent. is eliminated as creatinine, about 15 per cent. is retained by the muscle, while, if introduced in small amounts, as much as 50 per cent. may be metabolized. We are inclined to attach considerable significance to the slightly increased excretion of creatinine as indicating the metabolic relationship between these two substances. The creatine content of the muscle was raised from the normal of 0.52 per cent. to 0.55 per cent. (5 expts.) after the administration of creatine, and to 0.56 per cent. (3 expts.) after the administration of creatinine.

ANDREW HUNTER, M. H. GIVENS and C. M. GUION: *Studies in the Comparative Physiology of Purine Metabolism.*

PHILIP ADOLPH KOBER: *The Estimation of Protein, Amino and Nucleic Acids in Potable Waters.*

Experiments show that by using the right precipitants and evaporating to one tenth of the original volume proteins and nucleic acids can be estimated in potable waters by the author's nephelometric method. This method will easily reveal the presence of one part of substance in one million parts of water.

By using the copper method (to be described by the author in the next number of the *Journal of the American Chemical Society*) potable waters may be analyzed for amino acid nitrogen before or after hydrolysis. This method will reveal one part of amino acid nitrogen in one million of water, without difficulty.

HOWARD D. HASKINS: *The Acidity of Normal Urine.*

Certain modifications of Henderson's method were suggested. Permanent color standards were proposed for the range of acidity determined by paranitrophenol. A report was made of a study of variations of acidity in 24-hour samples and in fractional samples, *i. e.*, the day's urine collected in five periods. No relation of concentration of urine to acidity was found. The effect of diet was slight. Night urine was distinctly acid in 50 per cent. of the cases, and morning urine (breakfast to 11) was of very low acidity in 50 per cent. of the cases. Sweating seemed to have a marked effect in causing higher acidity.

MAX KAHN: *Metabolism Studies of Five Cases of Endarteritis obliterans.*

Five patients suffering from obliterating endarteritis were fed on a Folin diet and their metabolism studied. It was found that the nitrogen metabolism was normal but that the calcium and ethereal sulfates were increased in the urine.

MAX KAHN: *Calcium Content of Tuberculous Areas in Lung Tissue.*

Wherever the tubercle bacillus lodges it induces a deposition of calcium salts which hinders the ingress of more tubercle bacilli. The body in general becomes poorer in lime salts. It was found that tubercular areas in the lungs contained two to three times as much calcium as normal lung tissue. The work is in progress.

MAX KAHN and A. HYMANSON: *Metabolism Studies of Two Cases of Amaurotic Idiocy.*

Two cases of amaurotic family idiocy were kept under observation until death. The metabolism of nitrogen, sulfur and phosphorus was carefully

studied. It was found that both retention and absorption were normal or above normal. The digestive system does not seem to be at all deranged in this fatal disease.

T. L. Harkey: *Further Studies of Edema.*

Olive G. Patterson: *A Study of the Influence of External Hemorrhages on the Partition of Urinary Nitrogen.*

Victor E. Levine: *Biochemical Studies of Selenium.*

Benjamin Horowitz and W. J. Gies: *Pigments Produced from Thymol by Ammonium Hydroxide.*

Louis Berman and W. J. Gies: *A Differential Stain for Mucine and Mucoids.*

Max Kahn and W. J. Gies: *The Origin and Significance of Salivary Sulfocyanate.*

A. P. Lothrop and W. J. Gies: *Biochemical Studies of Dental Caries.*

W. J. Gies: *Further Studies of the Permeability of Lipin-Collodion Membranes.*

W. D. Bancroft: *Light and Health.*

(*To be concluded.*)

Charles L. Parsons,
*Secretary*

## SOCIETIES AND ACADEMIES

### THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and sixty-fifth regular meeting of the society was held at Columbia University on Saturday, October 25, extending through the usual morning and afternoon sessions. Thirty-three members were in attendance. President E. B. Van Vleck occupied the chair, being relieved by Professor H. S. White. The following new members were elected: R. W. Burgess, Cornell University; Tomlinson Fort, University of Michigan; Cora B. Hennel, Indiana University; Arthur Korn, Charlottenburg, Germany; J. H. Kindle, University of Cincinnati; M. A. Linton, Provident Life and Trust Company, Philadelphia; John McDonnell, Geodetic Survey of Canada; J. Q. McNatt, Colorado Fuel and Iron Company; T. E. Mason, Indiana University; B. E. Mitchell, Columbia University; George Paaswell, New York City; D. M. Smith, Georgia School of Technology; Panaiotis Zervos, University of Athens. Twelve applications for membership were received.

The meetings of the Chicago Section having been for some years of equal importance with the meetings held in New York and technically described as meetings of the society, it has been decided to obliterate this outgrown distinction by making the Chicago meetings also regular meetings of the society, so far as the presentation of scientific papers is concerned. The society will hereafter enjoy a possibly unique distinction, in that it will hold practically simultaneous meetings in two cities.

Following closely on the volume of the Princeton Colloquium Lectures, the society will shortly publish the Madison Colloquium Lectures of Professors L. E. Dickson and W. F. Osgood. This will be Volume IV. of the series of Colloquium volumes, its predecessors being the Boston, New Haven and Princeton Lectures.

It was decided to hold the summer meeting of 1914 at Brown University, in acceptance of the invitation by that university to participate in the celebration of its one hundred and fiftieth anniversary.

The following papers were read at the October meeting:

G. M. Green: "Projective differential geometry of one-parameter families of space curves, and conjugate nets on a curved surface."

G. M. Green: "One-parameter families of curves in the plane."

Edward Kasner: "The classification of analytic curves in conformal geometry."

G. H. Graves: "Systems of algebraic curves of least order for genera 3 and 4."

A. A. Bennett: "Quadri-quadric transformations."

A. A. Bennett: "A set of postulates for a general field admitting addition, multiplication, and an operation of the third grade."

T. H. Gronwall: "On analytic functions of several variables."

H. Galajikian: "Concerning the continuity and derivatives of the solution of a certain non-linear integral equation."

G. M. Green: "On the limit of the ratio of arc to chord at a point of a real curve."

W. H. Roever: "Geometric derivation of a formula for the southerly deviation of falling bodies."

The San Francisco Section held a meeting also on October 25. The Southwestern Section will meet at the University of Missouri on November 29. The society will meet in Chicago on December 26–27, and will hold its annual meeting in New York on December 30–31. At the latter meeting Professor H. B. Fine will deliver his presidential address on "An unpublished theorem of Kronecker respecting numerical equations."

F. N. Cole,
*Secretary*